The automatic generalisation of building polygons with ArcGIS standard tools based on the 1:50`000 Swiss National Map Series

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Quick overview

- Introduction
- Methodology in order to conduct the practical implementation
- Practical implementation: an overview of the generalisation steps
- Results and conclusion
Introduction
As part of the „International Master Program in Cartography“

+ Collaborative project

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Dominik Käuferle
Prof. Georg Gartner

+ swisstopoEDU-MSC Programm
Task

The automatic generalisation of buildings with ArcGIS for Desktop out-of-the-box generalisation functionalities

TLM (1:10,000) → DCM (1:50,000)

whilst maintaining the settlement structure

+ An exceptional generalisation challenge found within swisstopo is that of the individual house representation, a characteristic for which the Swiss national maps are famous for

+ Very time consuming task - automated solution is needed!
Methodology
Methodology for the practical implementation

1. Definition of the test area
   > Test area should have as many generalisation problems as possible
   > Test area should cover a wide variety of different settlement patterns
   > Generalised road network for 1:50,000 was provided
Methodology for the practical implementation

2. Requirement analyses

- Constraints are the basis and need to be satisfied within the results.
- Analysis and classification of swisstopo`s predefined constraints.
- Classification regarding generalisation considerations such as selection, form and graphic generalisation as well as the existing buildings and settlement structure.

- Buildings smaller than 5 sqm are not to be considered and can be omitted.
- The minimal dimension for a single house is 400 m².
- Buildings are only merged if they are not separated by a road axis.
- The ratio between built-up and vacant areas (black-white ratio) should be preserved when possible.
Methodology for the practical implementation

+ 3. Development of an automated workflow

  > Identification of all appropriate generalisation operators and their corresponding tools within ArcGIS for Desktop 10.2

  > Performing model- and graphic generalisation

  TLM 1:10`000 → Model Generalisation

  Symbolisation

  Cartographic Generalisation → DCM 1:50`000

  Constant review and improvement of the individual process steps

  > Improving the generalisation process by reviewing each step

  > Verifying the workflow and improving where needed

  > Concatenation of the steps to an overall workflow with the Model Builder
Practical implementation
Identification of all appropriate generalisation operators

++ Operators for model generalisation

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<thead>
<tr>
<th>Operatoren by Foerster et al.:</th>
<th>Corresponding tools within ArcGIS:</th>
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<td>Amalgamation</td>
<td>Aggregate Polygons</td>
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<td>Delineate-Built-Up Areas</td>
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<td>Simplification</td>
<td>Simplify Building</td>
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<td>Class Selection</td>
<td>Select Layer by Attribute</td>
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<td>Reclassification</td>
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<td>Collapse / Combine</td>
<td>No significant role</td>
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++ Operators for cartographic generalisation

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<td>Displacement</td>
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Model Generalisation

+ **Step 1: Aggregation of all buildings**
  > Buildings are captured by individual roofs
  > For further processing the building footprint is needed

+ **Step 2: Elimination of inner courtyards**

+ **Step 3: Spatial join to reattach the attributes**
Model Generalisation

+ **Step 4:** Initial simplification of all buildings
  > Best results when removing little details in advance
  > Processing simplification after aggregation led to better results

+ **Step 5:** Add a hierarchy field in order to calculate building hierarchies
+ **Step 6:** Selection and classification of buildings according to their size
Model Generalisation

Step 7: Simplification of buildings according to the size/hierarchy

- Small buildings should be squared off
- Larger buildings should retain their particular footprint
- Simplification tolerance is reduced according to the size of the building

- Hierarchy 3 (yellow): > 250m²
- Hierarchy 2 (orange) 250 – 756 m²
- Hierarchy 1 (green) 756 – 1000 m²
- Hierarchy 0 (blue) < 1000 m²
Model Generalisation

+ Step 8: Selection and elimination of the smallest buildings
  > Mainly private garages
  > Elimination in order to maintain a better representation of the terraced house structure
Model Generalisation

+ **Step 9: Selection and elimination of small buildings in dense settlement areas**
  > Small buildings outside the dense area should be kept
  > Identification of dense areas with the delineate built-up area tool
  > Selection of features by location and elimination
Model Generalisation

+ **Step 10: Selection and elimination of small buildings around large ones**
  > Large buildings are of major importance and require more space in order to be preserved whilst conducting the graphic generalisation

+ **Step 11: Reclassification of buildings along a street**
  > Generate a buffer around the road network, select hierarchy 2 buildings and reclassify to 1, select hierarchy 3 buildings and reclassify to 2
Cartographic Generalisation

+ A number of pre-processing steps proved necessary before running the Resolve Building Conflict tool

+ Step 12: Add extra fields which are populated when the tool is executed
  > invisibility and resolve building conflict size field

+ Step 13: Symbolisation of all building features and defining them as cartographic representations

+ Step 14: Manipulating the road conflict barrier layer
  > House edge must be overlapped by the road network signature with 3m
  > Original streets symbol width is reduced by this value and used as the conflict barrier layer
  > This is necessary because the Resolve Building Conflict tool automatically snaps the buildings to the defined barrier features
Cartographic Generalisation

+ **Step 15: Resolve Building Conflicts**
  > The tool separates buildings from each other and from any defined barriers whilst retaining the relative density and pattern
  > Define minimum allowable building size
  > Define building gap
  > Assigning the hierarchy value
  > Managing the distance and orientation from and to the barrier features
Concatenation of the tools to an automated workflow

1 – 4: Model generalisation

5: Cartographic generalisation
Results and Conclusion
Detailed results TLM 1:10,000 and DCM 1:50,000
Conclusion

- Promising opportunities for automated generalisation in ArcGIS regarding the expert evaluation
  - Fulfilling the requirement of swisstopo for retaining the individual house representation and this whilst maintaining the existing settlement structure
  - Swisstopo confirmed that this workflow achieved a very high acceptance level

- A number of problem areas have been identified where the adaption of parameters is necessary
  - In very dense areas the settlement structure was considered problematic
  - Higher simplification of large building boundaries
  - Problems when generalising very complex building boundaries such as the historic old town
  - Minimum dimensions and minimum distances are not always correct
Outlook

+ Problem areas can be definitely refined by further investigation and in the adjustment of parameters

+ Some tasks need more creativity to find a possible workaround such as for generalising the historic old town

+ The buildings were considered only as one single feature type: more investigation needed for the aggregation of buildings when having more than one feature type

+ Preservation of feature links

+ Consideration of the “Big Picture” when generalising
Thank you for your attention!

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