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

18th ICA Workshop on Generalisation and Multiple Representation

Rio de Janeiro, August 21st 2015

Anna Vetter

a.vetter@esri.ch

esri Suisse

Quick overview

- **+ Introduction**
- **+ Methodology in order to conduct the practical implementation**
- **+ Practical implementation: an overview of the generalisation steps**
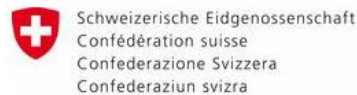- **+ Results and conclusion**

Introduction

As part of the „International Master Program in Cartography"

+ Collaborative project

Anna Vetter, Mark Wigley

Dominik Käuferle

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Landestopografie swisstopo
Office fédéral de topographie swisstopo
Ufficio federale di topografia swisstopo
Uffizi federal da topografia swisstopo

Prof. Georg Gartner

TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology

+ swisstopoEDU-MSC Programm

Task

The automatic generalisation of buildings

TLM (1:10`000) ⟶ DCM (1:50`000)

whilst maintaining the settlement structure

with ArcGIS for Desktop out-of-the-box generalisation functionalities

+ **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

18th ICA Workshop on Generalisation and Multiple Representation, Rio de Janeiro, August 21st 2015

Methodology for the practical implementation

+ 1. Definition of the test area

  > Testarea should have as many generalisation problems as possible

  > Testarea 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

> Contraints 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
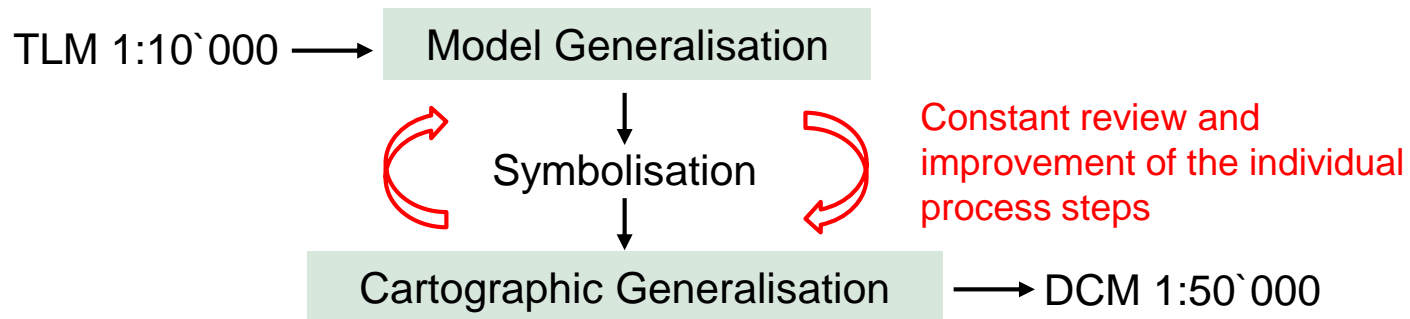
✚ Buildings smaller than 5 sqm are not to be considered and can be omitted

✚ The minimal dimension for a single house is 400 m^2

✚ Buildings are only merged if they are not separated by a road axis

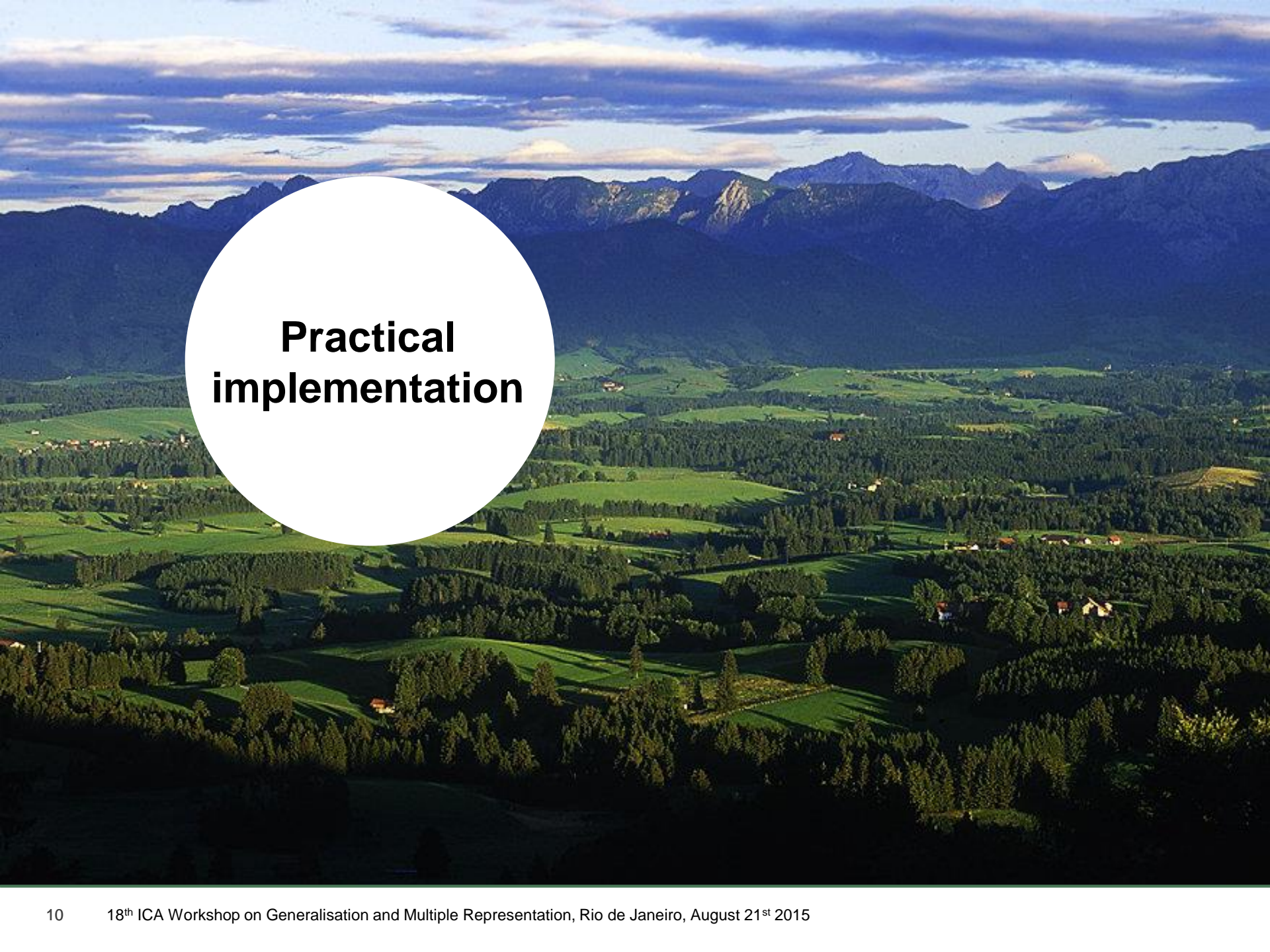**✚ The ratio between built-up and vacant areas (black-white ratio) should be preserved when possible**

Methodology for the practical implementation

+ 3. Development of an automated workflow

> Identification of all appropritate 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

18th ICA Workshop on Generalisation and Multiple Representation, Rio de Janeiro, August 21st 2015

# Identification of all appropritate generalisation operators

+ Operators for model generalisation

Operatoren by Foerster et al.:	Corresponding tools within ArcGIS:
Amalgamation	Aggregate Polygons Delineate-Built-Up Areas
Simplification	Simplify Building
Class Selection	Select Layer by Attribute Select Layer by Location Select (SQL expression)
Reclassification	Field calculator
Collapse / Combine	No significant role
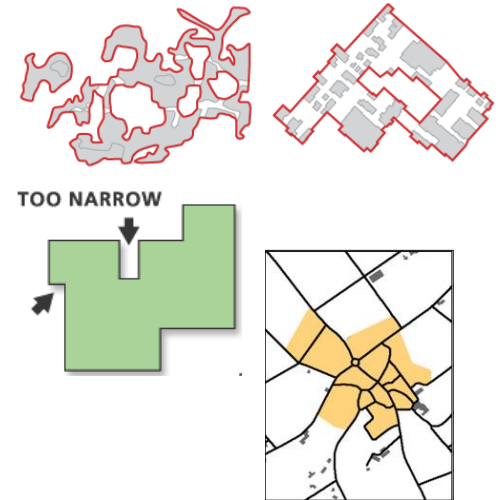
+ Operators for cartographic generalisation

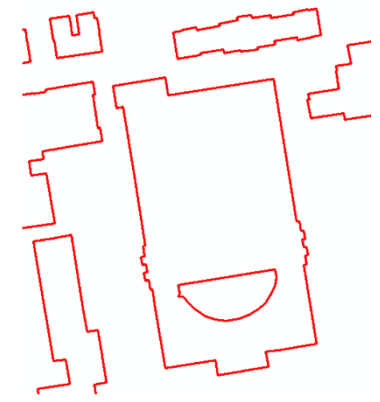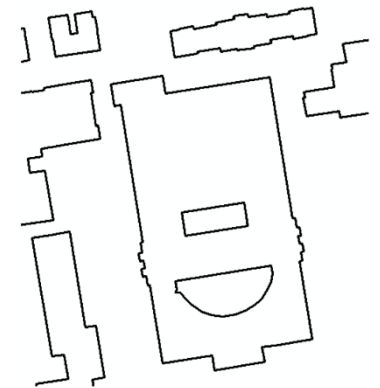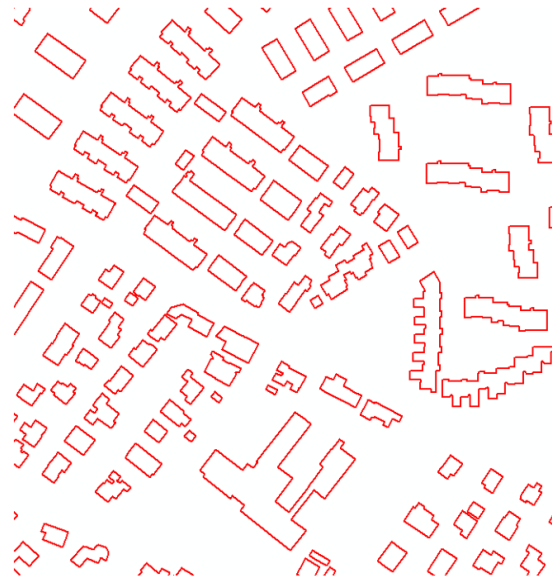| Operatoren by Foerster et al.:	Corresponding tool within ArcGIS:
Displacement	
Typification	
Enhancement	Resolve Building Conflict
Amalgamation	
Elimination	
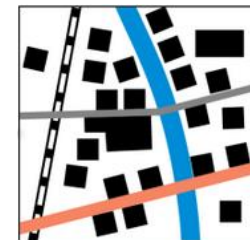
Model Generalisation

+ Step 1: Aggregation of all buildings

> Buildings are captured by individual roofs

> For further processing the building footprint is needed
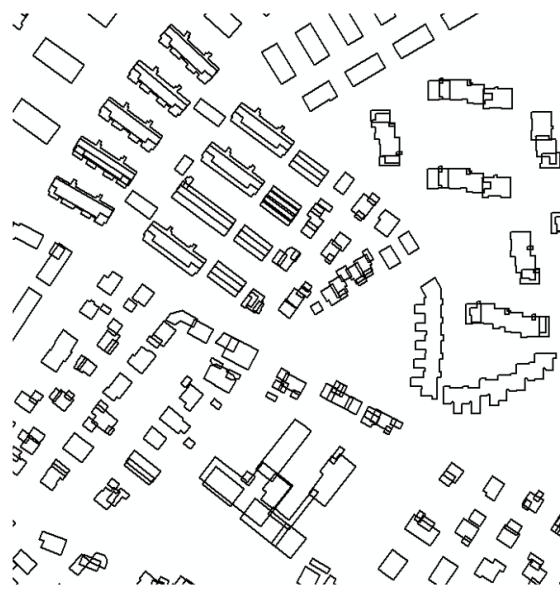
Step 1

Step 2

+ Step 2: Elimination of inner courtyards

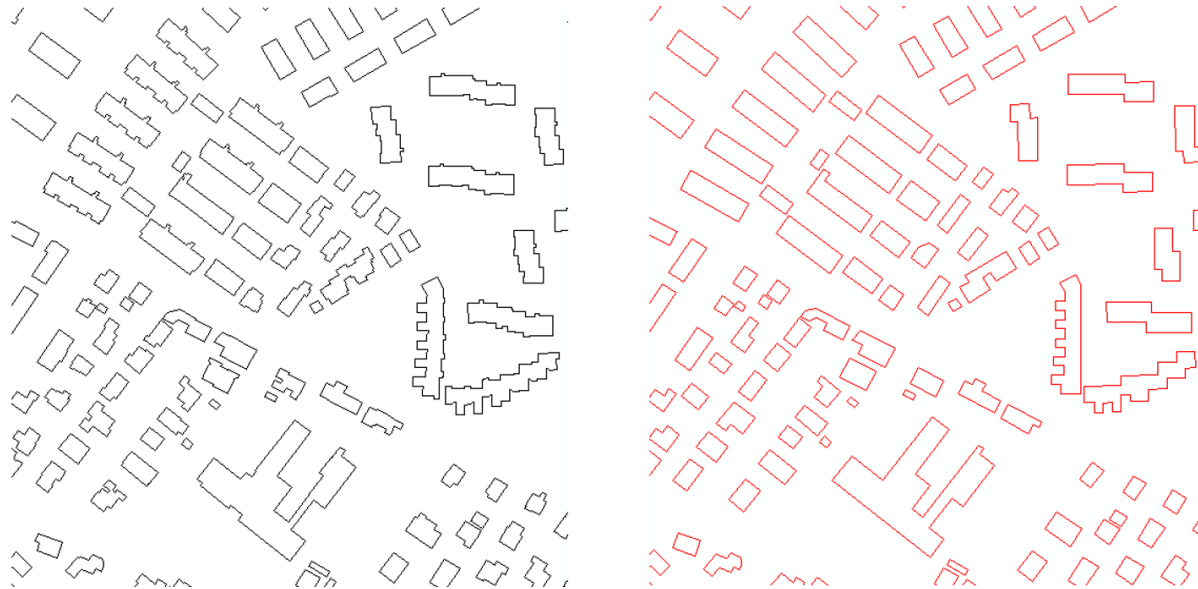**+ Step 3: Spatial join to reattach the attributes**

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 4

+ 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

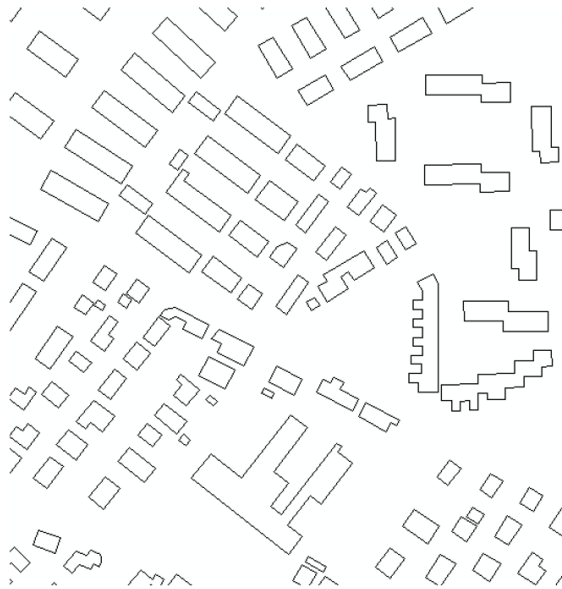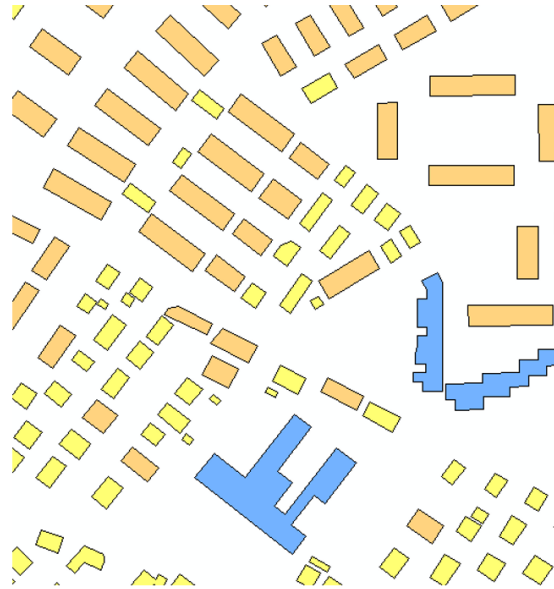**+ Step 7: Simplification of buildings according to the size/hierarchy**

> Small buildings should be squared off

> Larger buildings should retain their particular footprint

> Simplification tolerance is reduced according to the size of the building

Step 7

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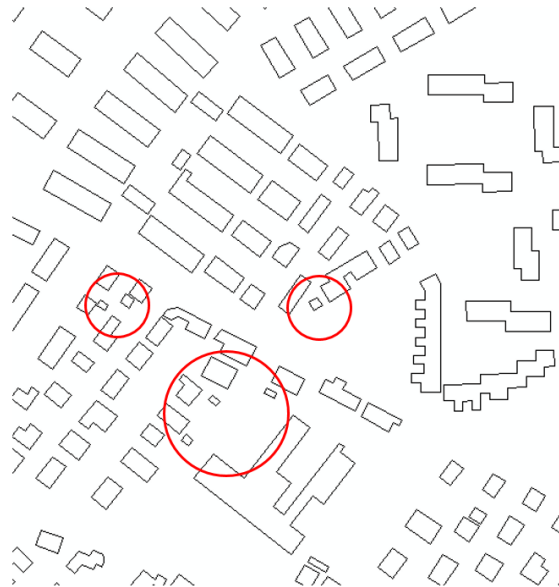- Hierarchy 0 (blue) < 1000 m2
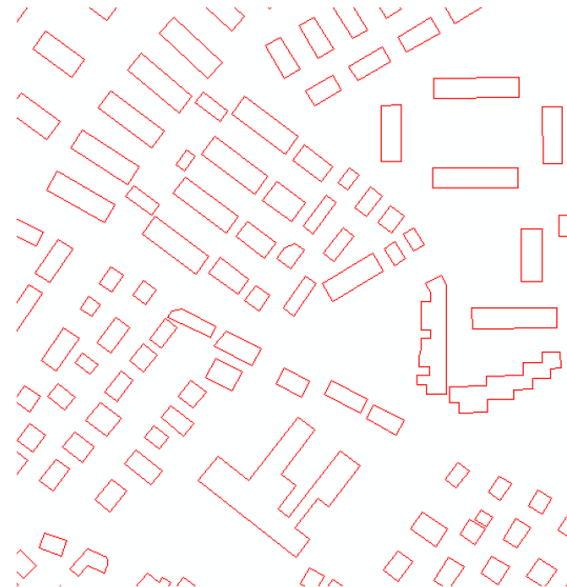
Model Generalisation

+ 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

Step 8

Model Generalisation

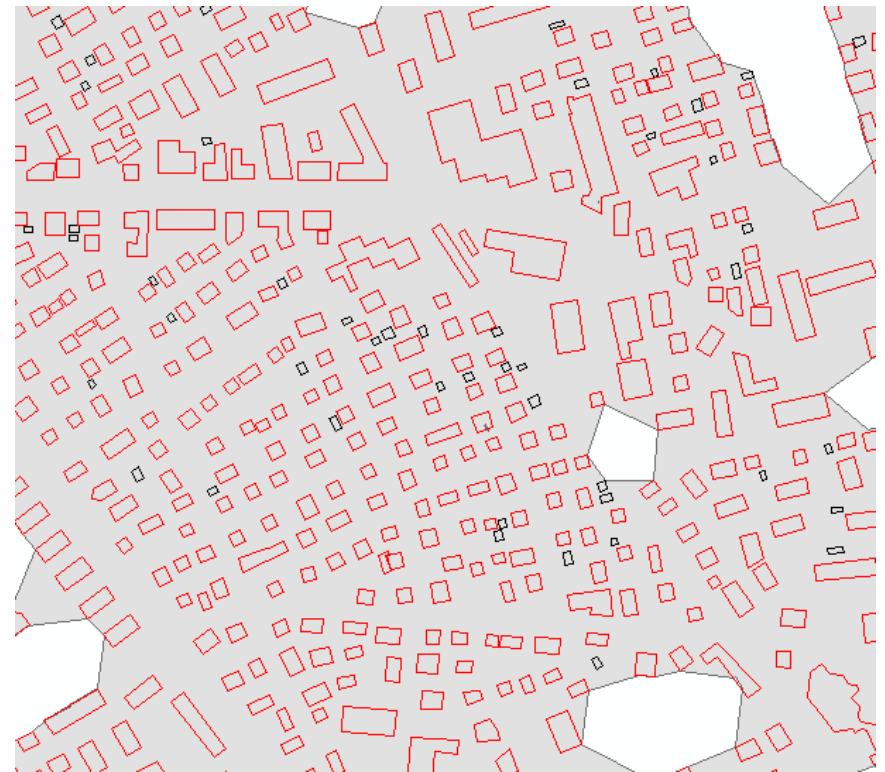**+ Step 9: Selection and elimination of small buildings in dense settlement areas**

> Small buildings outside the dense area should be kept

> Identification of dense areas with the delinate built-up area tool

> Selection of features by location and elimination
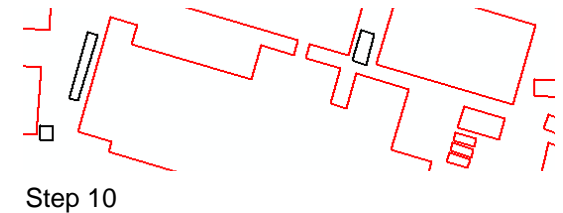

Step 9

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 10

+ 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
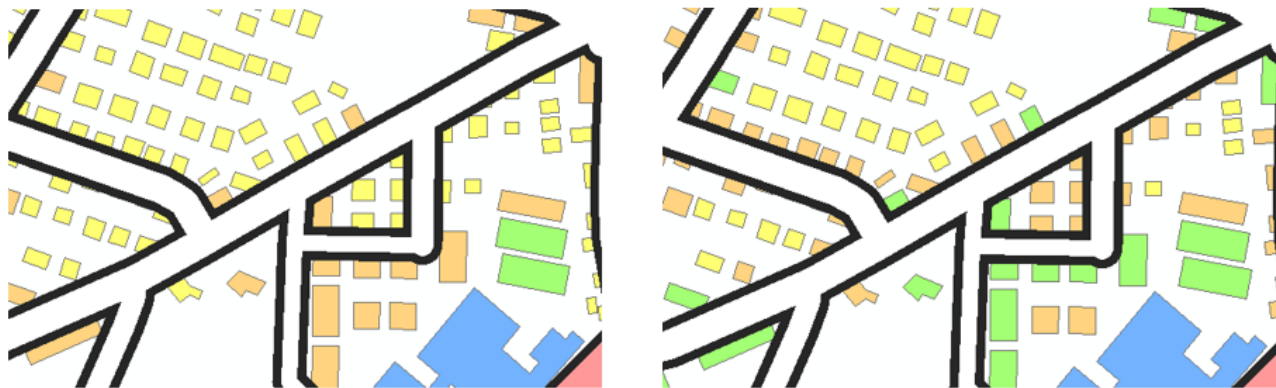
Step 11

TLM 1:10`000 ⟶ **Model Generalisation**

↓

Symbolisation

↓

Cartographic Generalisation ⟶ DCM 1:50`000

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

18th ICA Workshop on Generalisation and Multiple Representation, Rio de Janeiro, August 21st 2015

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

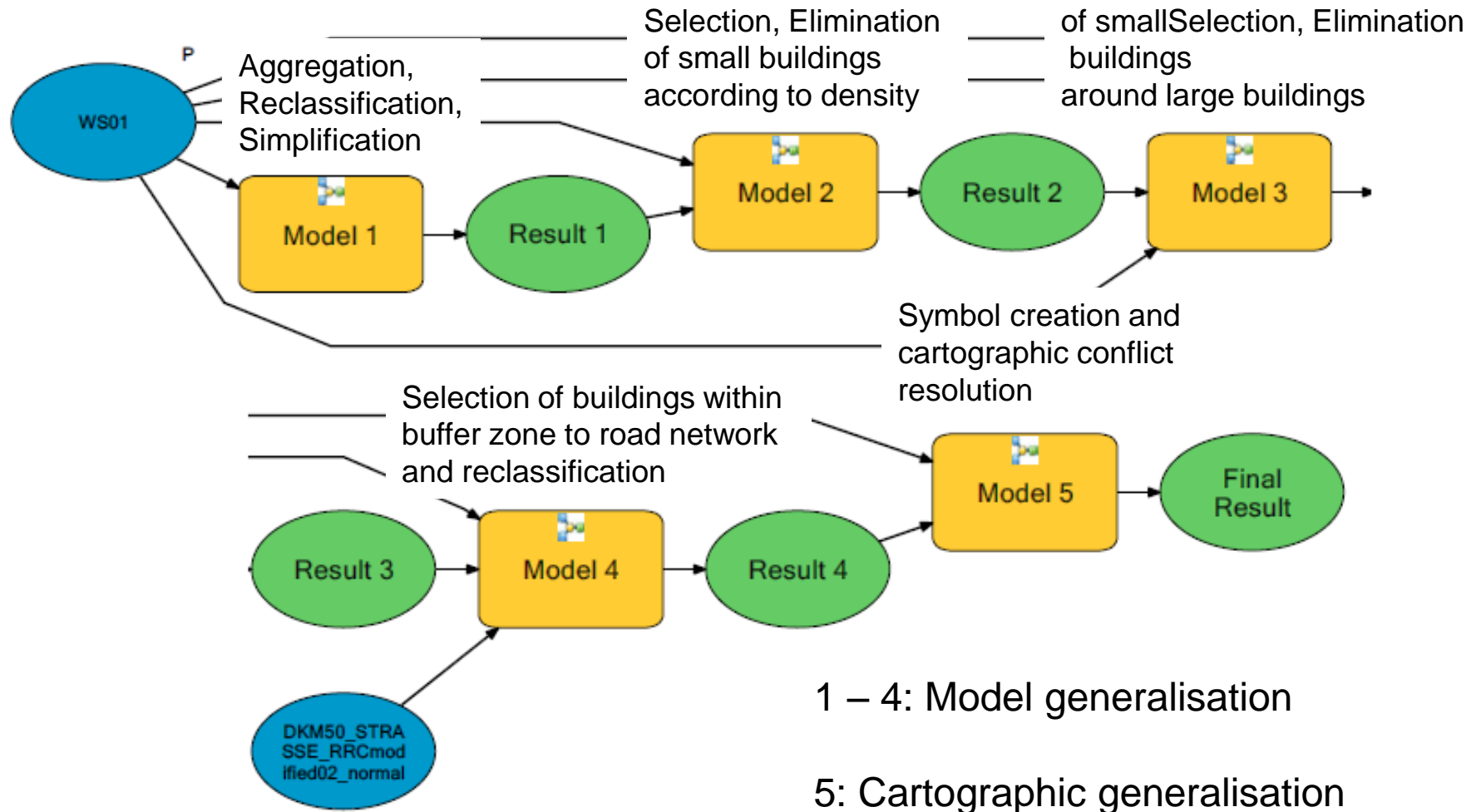> Managing the distance and orientation from and to the barrier features

Step 15

Concatenation of the tools to an automated workflow

1 – 4: Model generalisation

5: Cartographic generalisation

Results
and
Conclusion

18th ICA Workshop on Generalisation and Multiple Representation, Rio de Janeiro, August 21st 2015

Detailed results TLM 1:10`000 and DCM 1:50`000
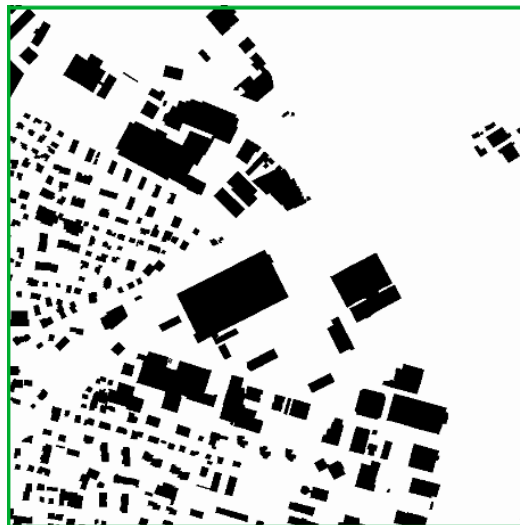
Conclusion

+ 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!

a.vetter@esri.ch

18th ICA Workshop on Generalisation and Multiple Representation, Rio de Janeiro, August 21st 2015