Agent-based polygon generalization

Martin Galanda

GIS Division, Department of Geography

University of Zurich

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Project objectives

Automation of polygon generalization by means of a multi-agent system

- Orchestration of methods for polygon generalization such as algorithms, measures, constraints etc.

- continuation of the AGENT project
  (funded by EU 1997-2000)

Generalization Constraints

	map	group		group/polygon	polygon			line	
	Reclassification	Aggregation	Typification	Displacement	Exaggeration	Elimination	Enlargement	Simplification	Smoothing
M1 Consecutive vertex distance	+	~	~		~	+	+	++	++
M2 Outline granularity	+	~	~		~	+	+	++	++
M3 Distance btw. boundary points	+	~	~		++	+	+	+	+
M4 Minimal area	+	++	++		+	++	++	~	~
M5 Respect spatial context	+	++	++	++	++	+	-	~	~
M6 Object separation	+	++	++	++	++	+	--	~	~
M7 Number of categories	++								

Generalization constraints

- "Design specification, to which solutions should adhere" (Weibel and Dutton 1998)
- Are linked to (Ruas 1999, Barrault et al. 2001)
  - Spatial level
  - Goal value
  - Measure
  - Evaluation method
  - Importance and Priority
  - List of plans

Sample constraint: M4 Minimal Area

- Spatial Level

  Polyon

- Goal value

  4 mm^2 (map units)

- Measure

  Area measure

Sample constraint: M4 Minimal Area

- Evaluation method

Current area / Goal value	Severity
<25%	very bad (1)
25 - <=50%	bad (2)
50 - <=75%	medium (3)
75 - <=95%	good (4)
> 95%	perfect (5)

Sample constraint: M4 Minimal Area

- Importance (from highest to lowest)
    - Topological constraints
    - **M4 Minimal Area**
    - Other metric and procedural constraints
    - Structural constraints

- Priority (from highest to lowest)
    - **M4 Minimal Area**
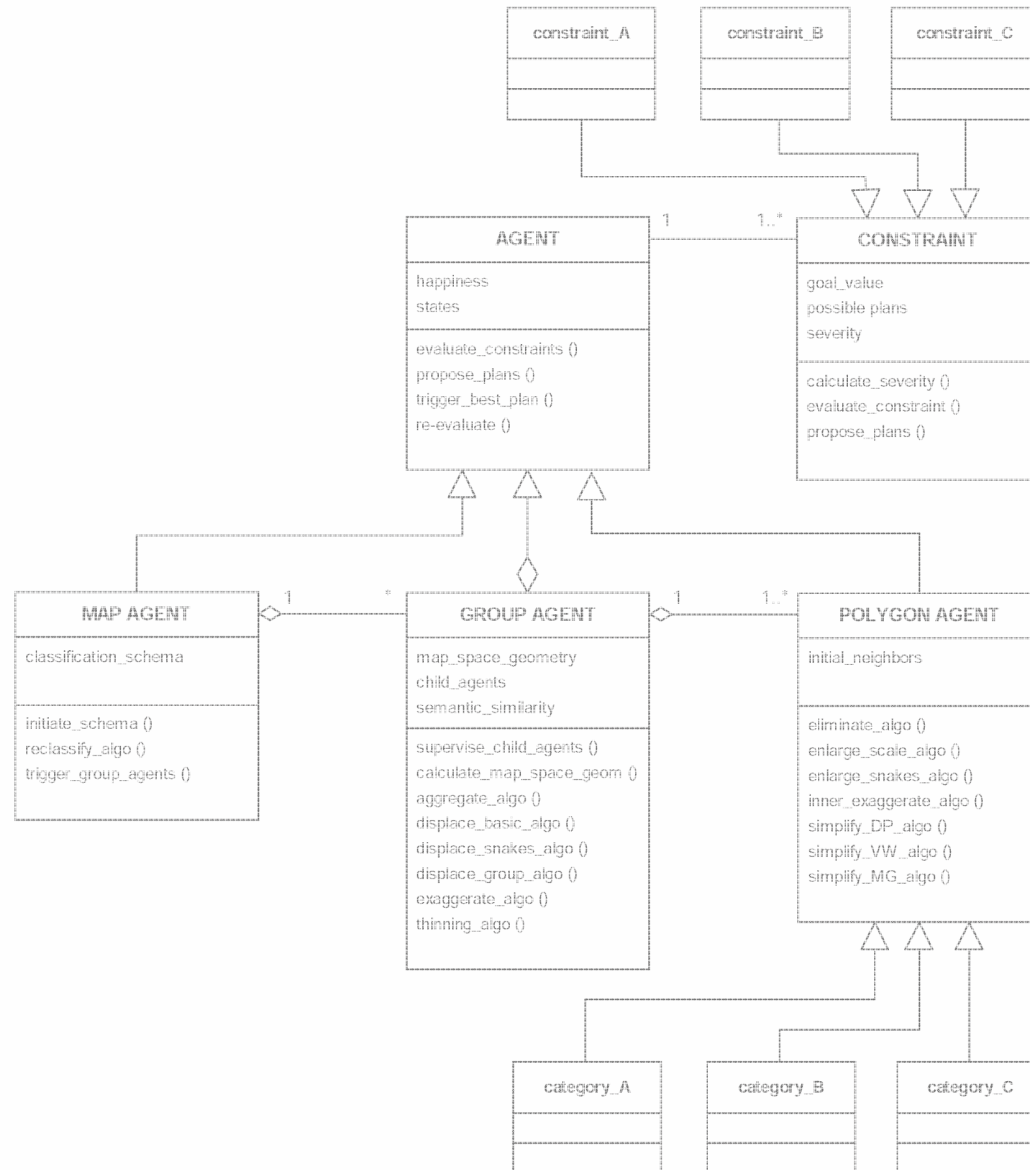   - Other metric and procedural constraints

Sample constraint: M4 Minimal Area

- List of plans

	situation				
	1	**2**	**3**	**4**	**5**
relative size (%) (severity of constraint)	< 25	25 - <75	25 - <75	75 - 95	> 95
semantic importance (additional criteria)		high	low		
triggered operation	elimination	enlargement	elimination	enlargement	-

Test case

Prototype characteristics

- GIS LAMPS2 was extended in AGENT project to incorporate an agent interference engine

- 3 agent types (map, group, polygon)
- Group agents defined manually
- 16 constraints and measures
  (e.g. minimal area, nr. of categories, size ratios)
- 15 algorithms for 8 generalization operations
  (e.g. Enlargement by scaling and snakes, aggregation by convex hull)
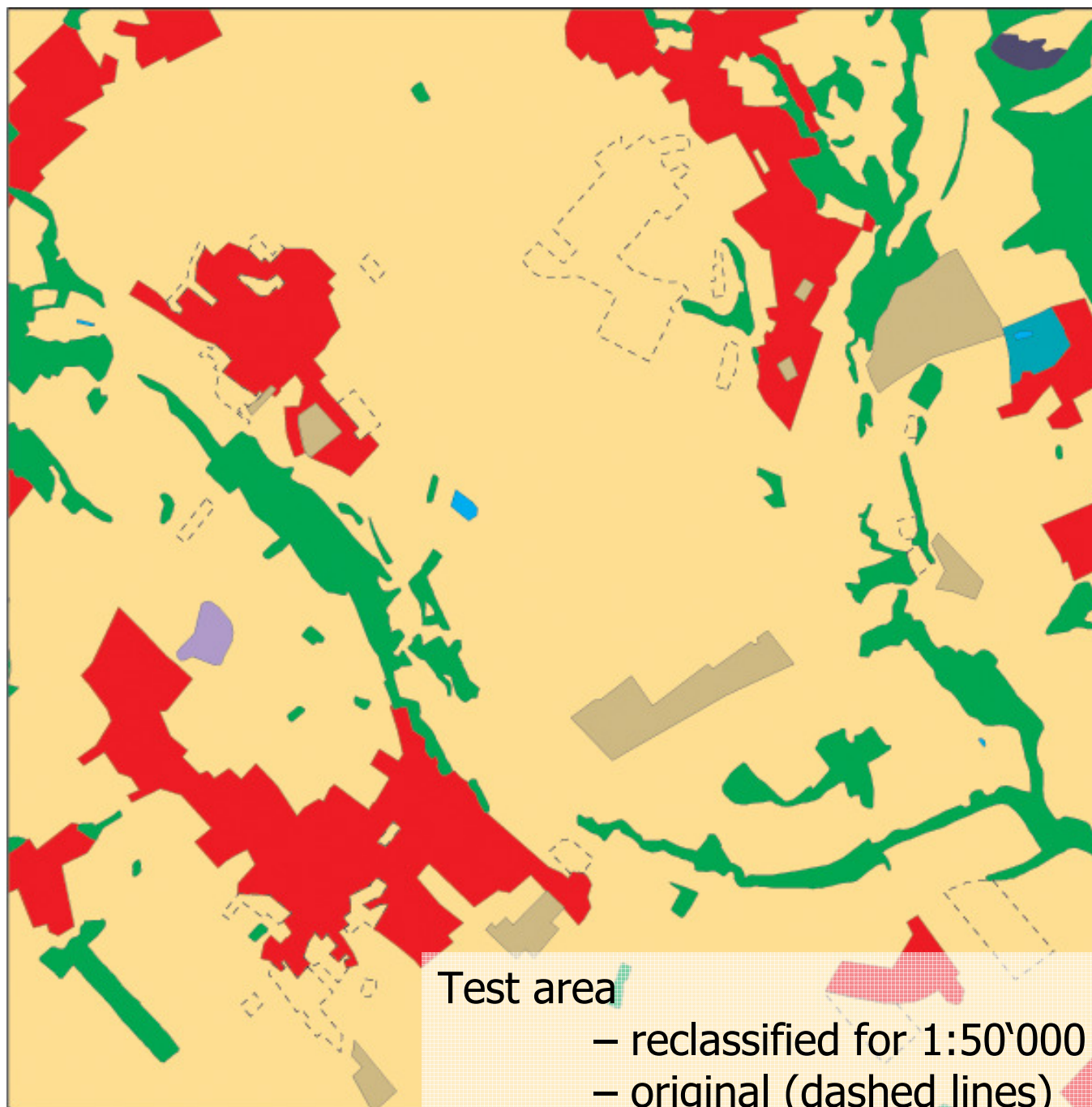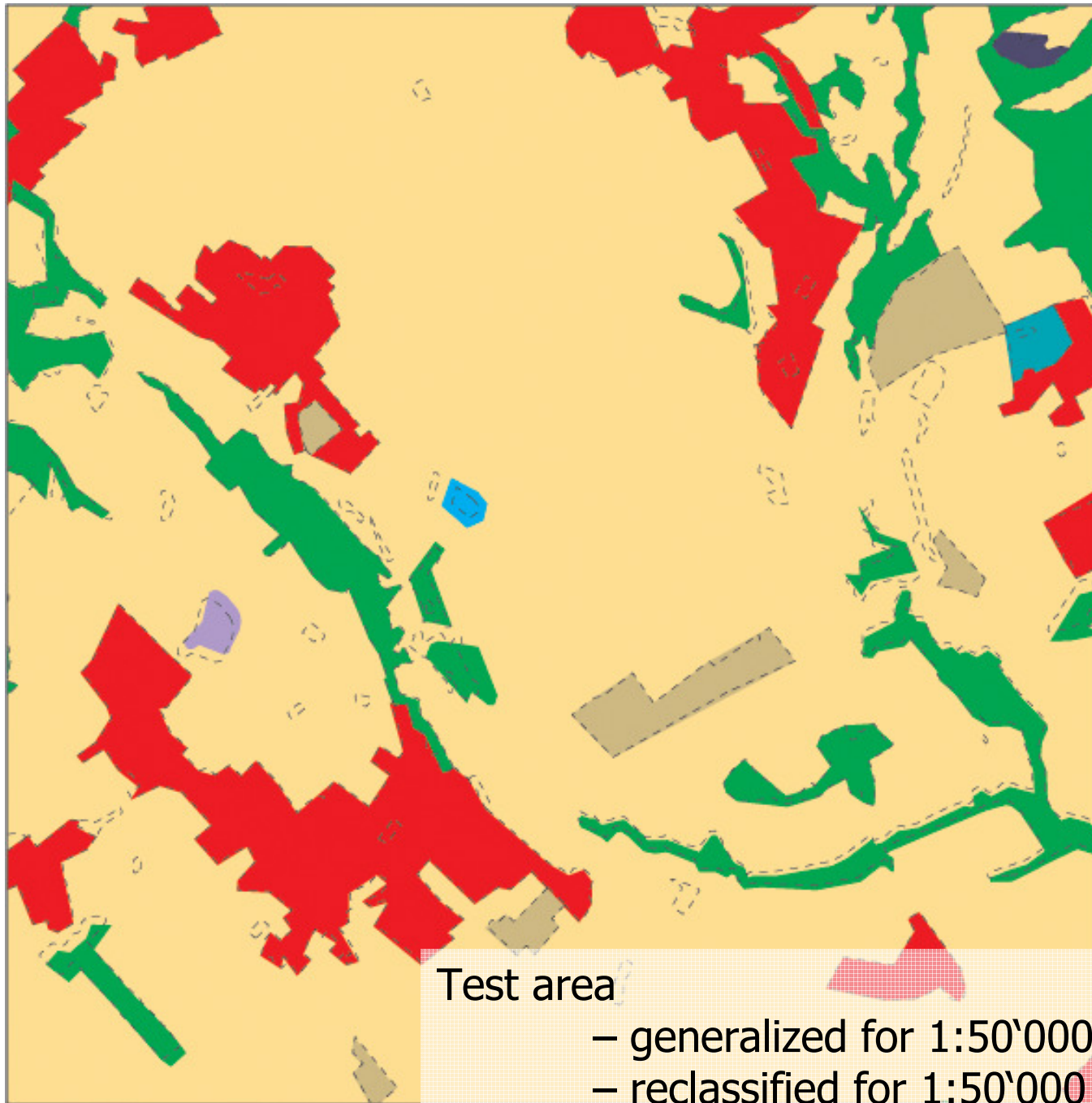
Test case

- Data

  ‚primary surfaces' layer of VECTOR25

- Scale range

  1:25'000 to 1:50'000 (1:100'000, 1:200'000)

- Testarea

  3 x 3 km^2 (12 categories)

- Method

  fully automated generalization

Test area
- original

Test area
– reclassified for 1:50'000 (solid cont.)
– original (dashed lines)

Test area
– generalized for 1:50'000 (solid cont.)
– reclassified for 1:50'000 (dashed lin.)

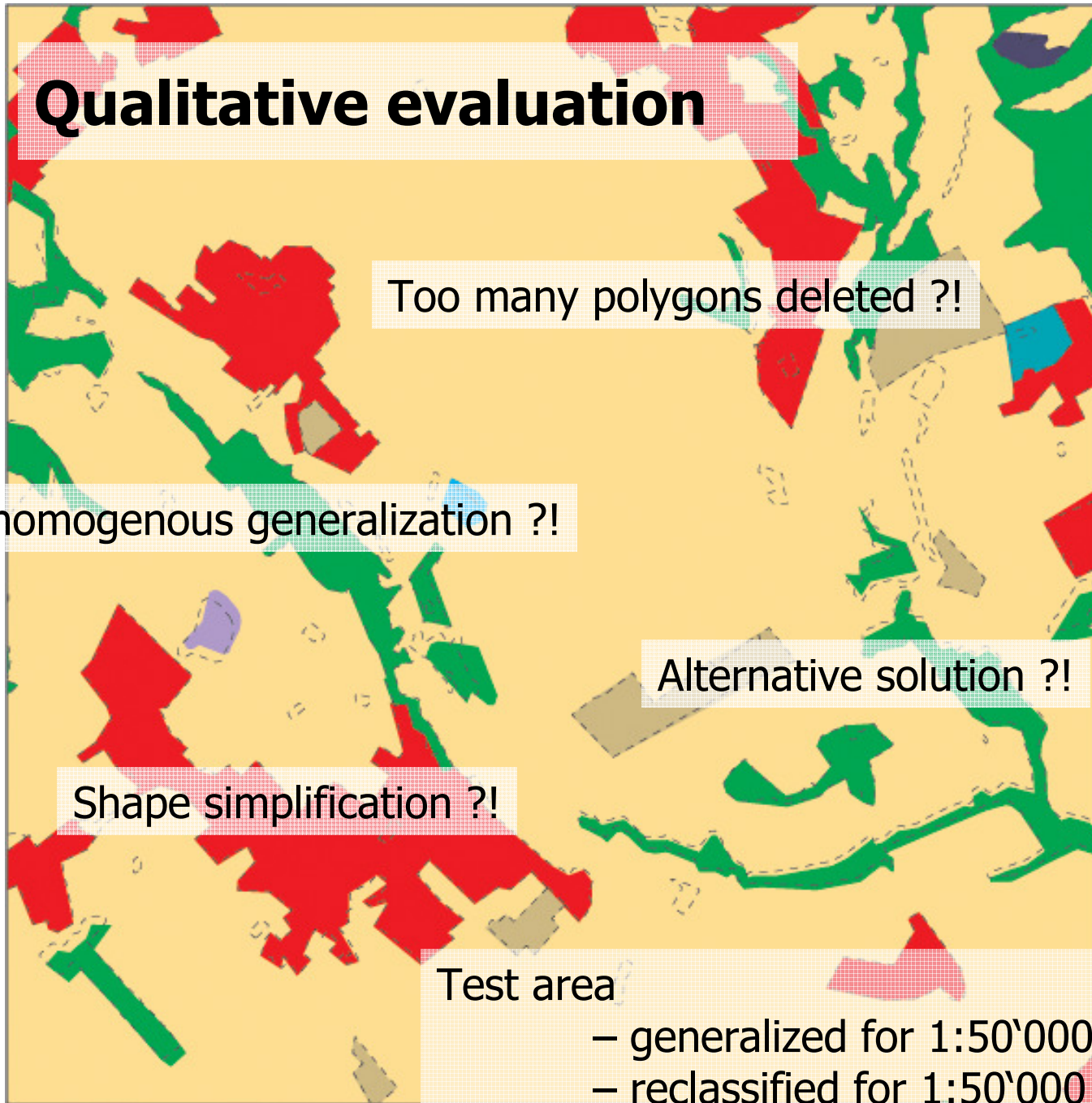**Qualitative evaluation**

Too many polygons deleted ?!

Inhomogenous generalization ?!

Alternative solution ?!

Shape simplification ?!

Test area
– generalized for 1:50'000 (solid cont.)
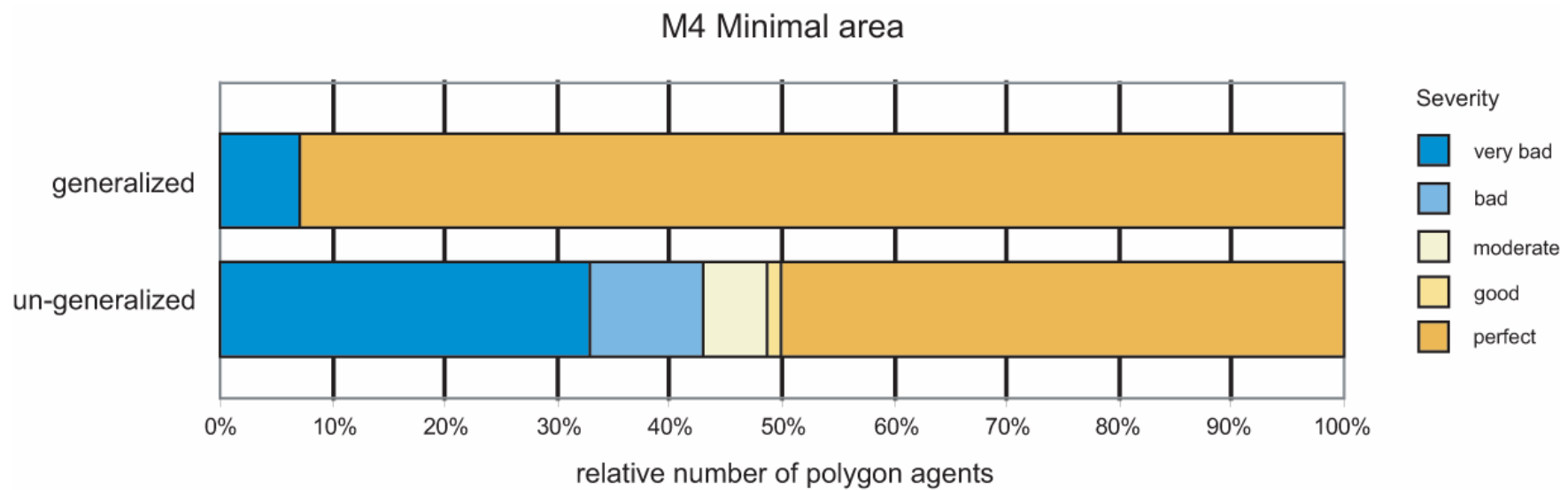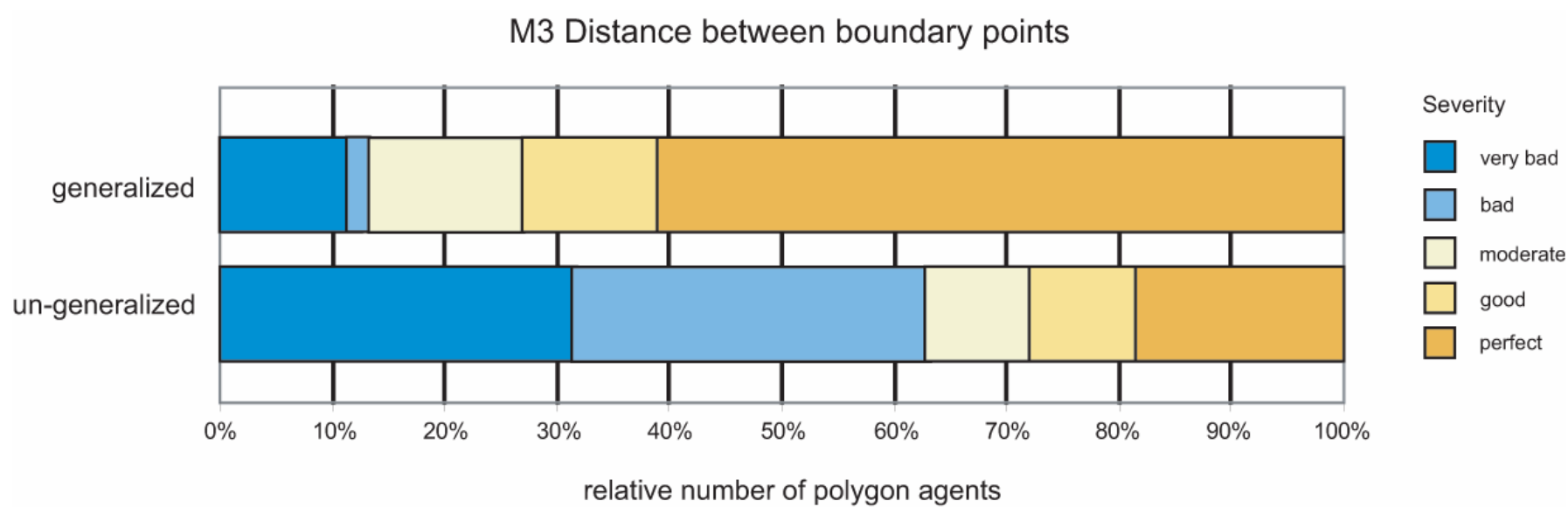– reclassified for 1:50'000 (dashed lin.)

Quantitative evaluation

- 26 group agents
  - 5 eliminated
  - Average satisfaction increased from 2.5 to 3.8
- 78 polygon agents
  - 34 eliminated
  - Average satisfaction increased from 2.7 to 4.1
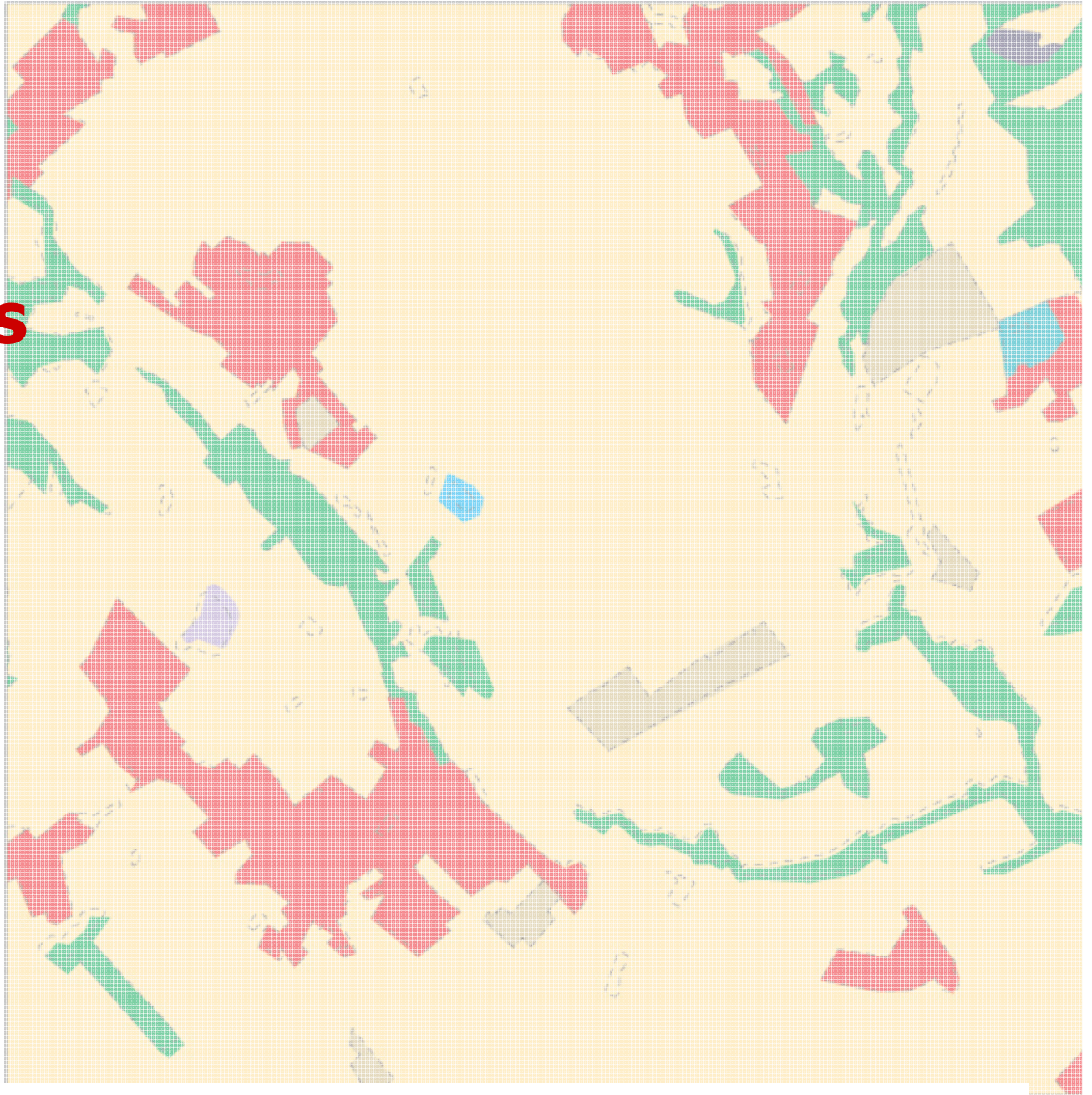
Improvement of polygon agents

count generalized polygon agents

metric satisfaction	1	2	3	4	5	total
1	0					0
2		1	1	1	4	7
3			9	9	9	27
4				1	4	5
5					5	5
total	0	1	10	11	22	44

count ungeneralized polygon agents

M3 Distance between boundary points

M4 Minimal area

Improvement of group agents

count generalized group agents

basic satisfaction	1	2	3	4	5	total
1	0	0	2		1	3
2			1	2		3
3			3	4	5	12
4				1	2	3
5						0
total	0	0	6	7	8	21

count ungeneralized grouo agents

Conclusions

Conclusions

- First implemented framework for 'comprehensive' polygon generalization
- Testbed for future research (orchestration and indiv. generalization tools)
- Promising results on VECTOR25
- Additional research (development) on level of methods (e.g. Structural constraints, shape simplification algorithms, negotiation)

Discussion

Martin Galanda

mgalanda@geo.unizh.ch