

# Optimization techniques for polygon generalization

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# Optimization techniques for polygon generalization

## 1 Introduction



## 2 Properties of Optimization Techniques (OT)

## 3 Snakes, one OT, in polygon generalization

## 4 How to proceed ...

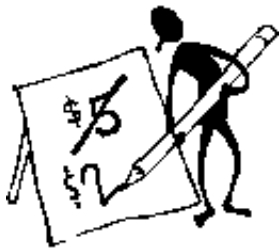
# Optimization techniques for polygon generalization

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Introduction

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Properties of Optimization Techniques (OT)



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Snakes, one OT, in polygon generalization

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How to proceed ...

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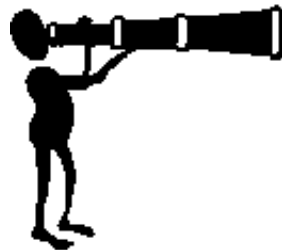
Introduction

2

Properties of Optimization Techniques (OT)

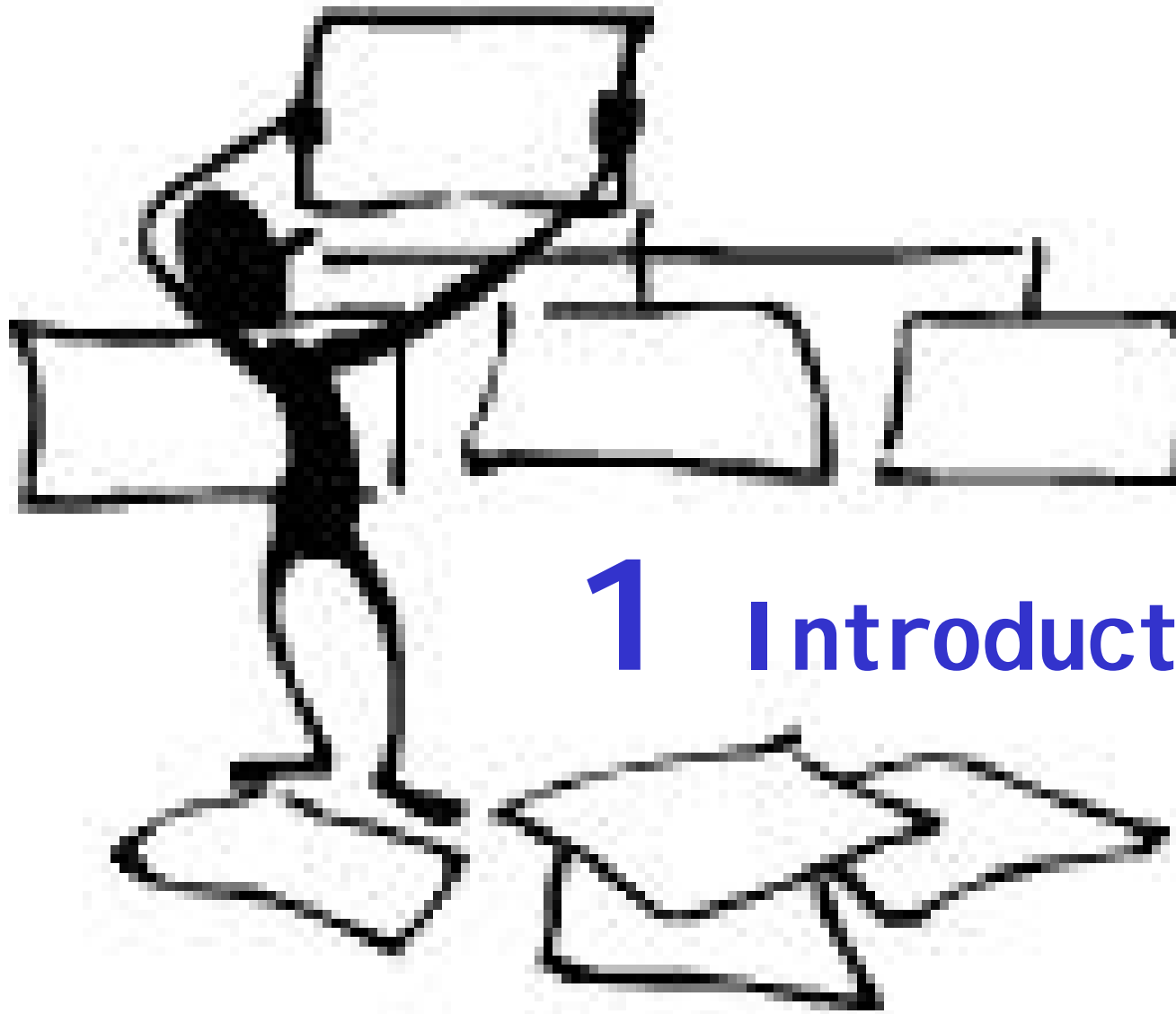
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Snakes, one OT, in polygon generalization



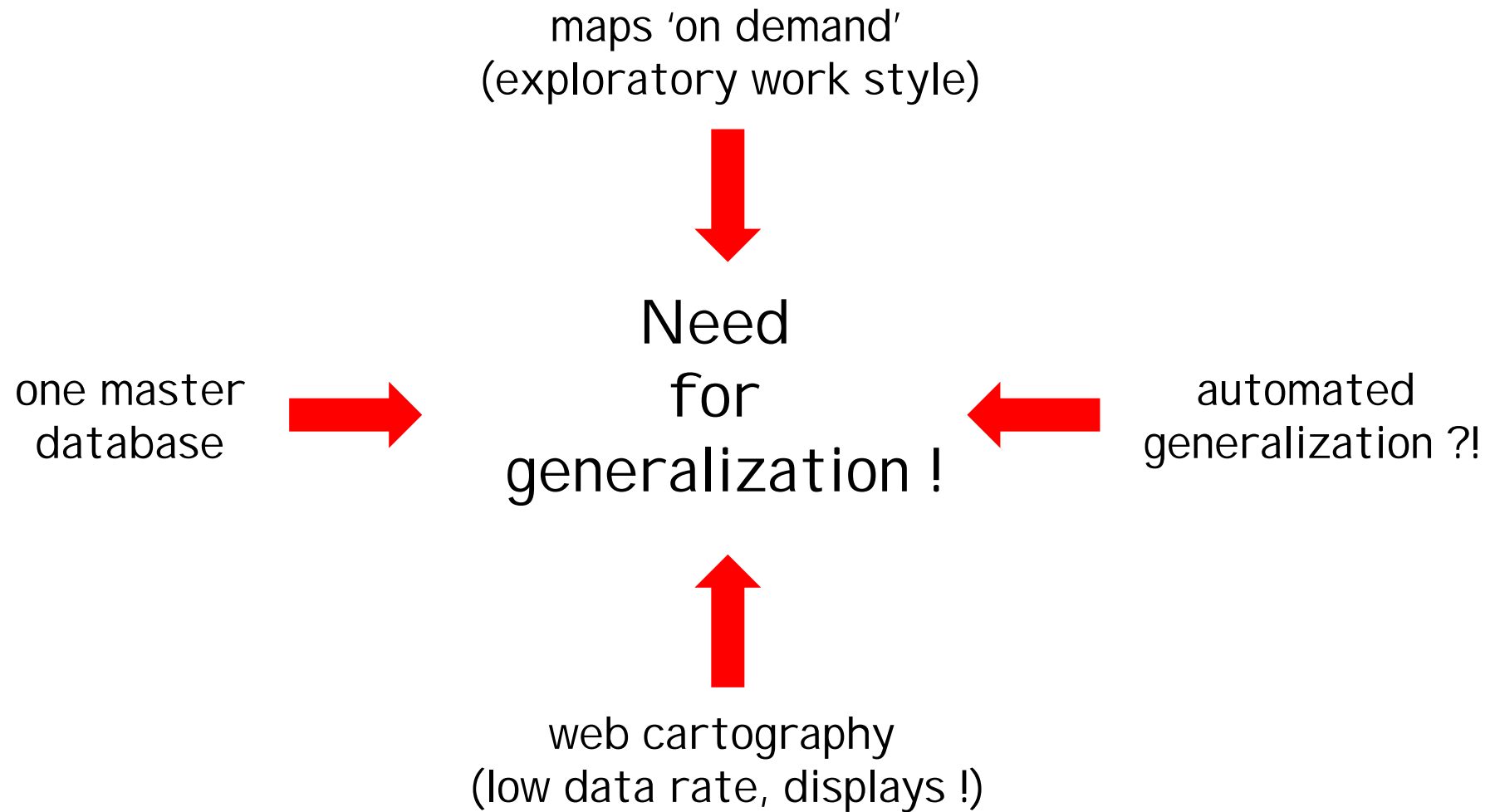
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How to proceed ...



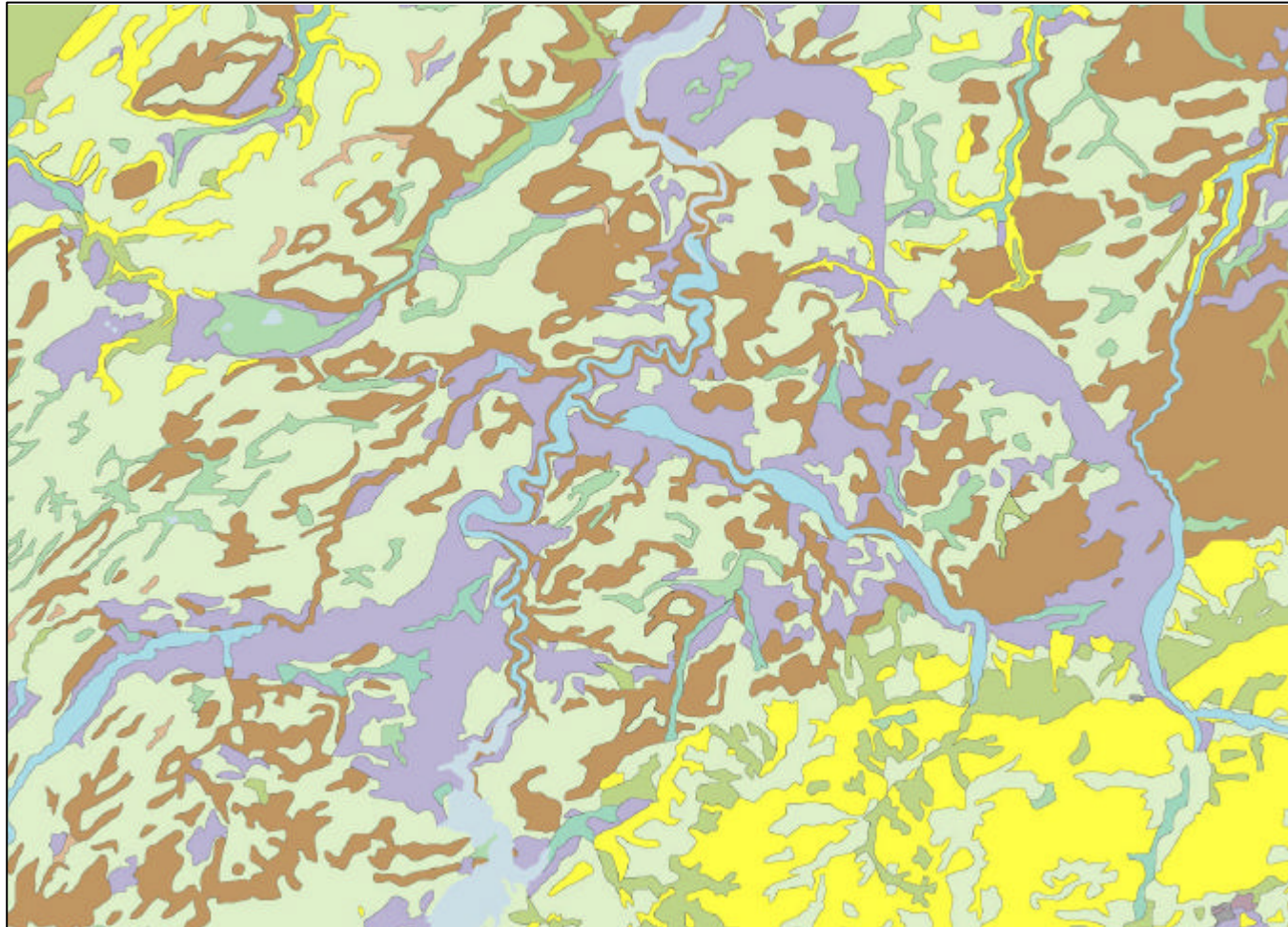
# 1 Introduction

# Motivation





## Categorical data



Saane, geology 1:100000

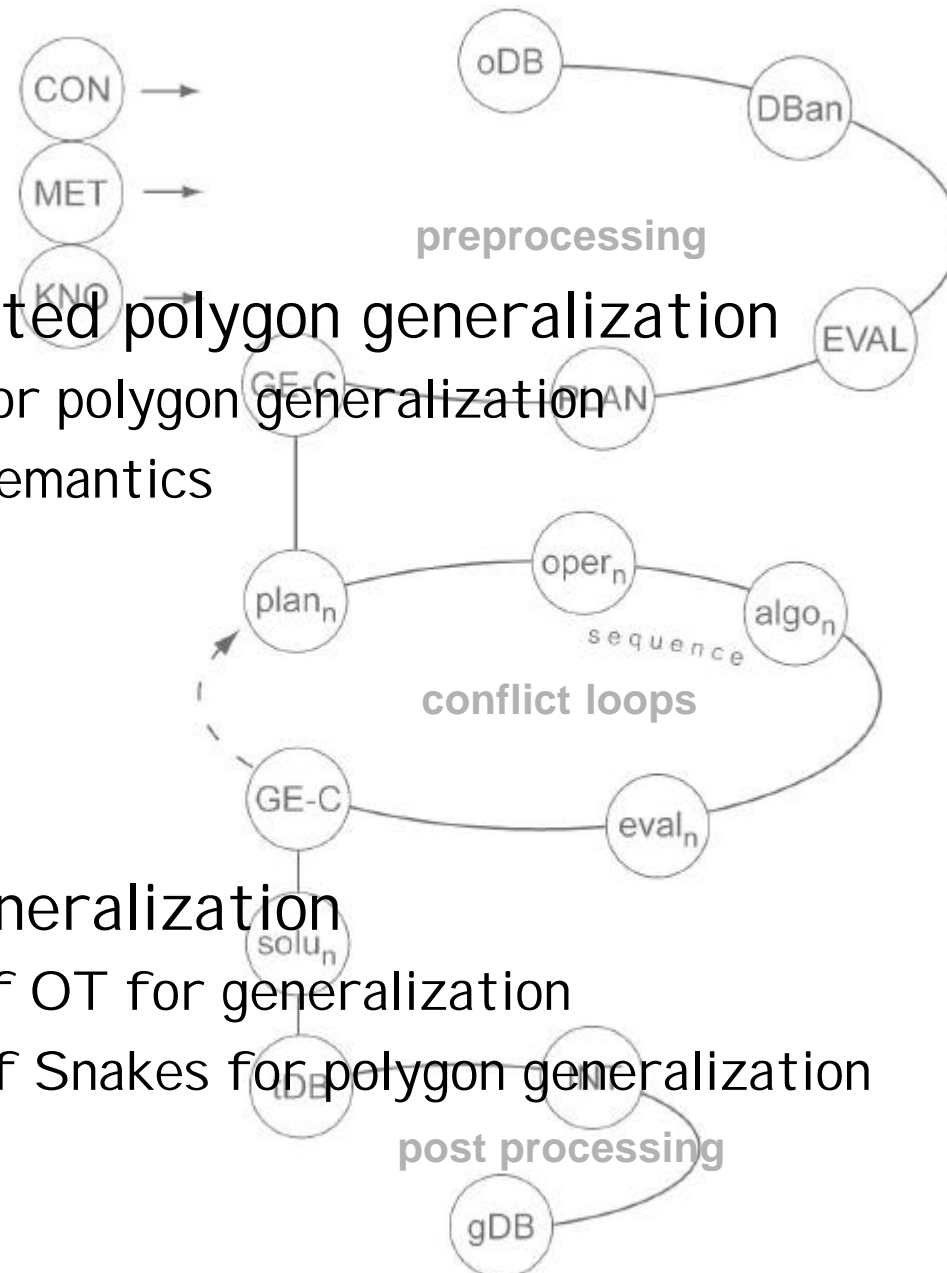


# PhD

- algorithms for polygon generalization
- the role of semantics
- strategy
- automation

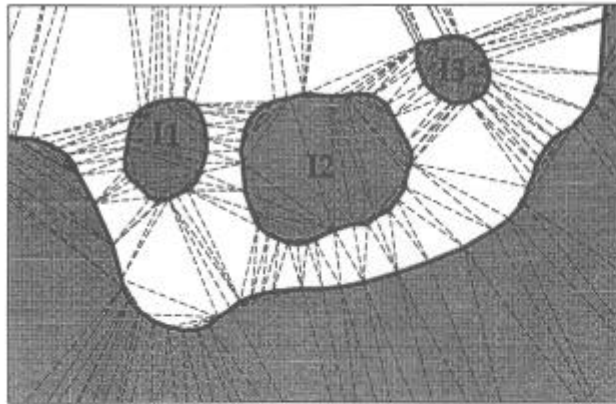
# OT for polygon generalization

- properties of OT for generalization
- application of Snakes for polygon generalization

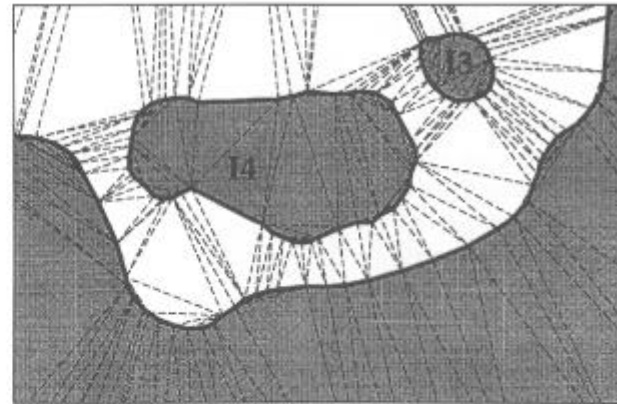


# Existing algorithms

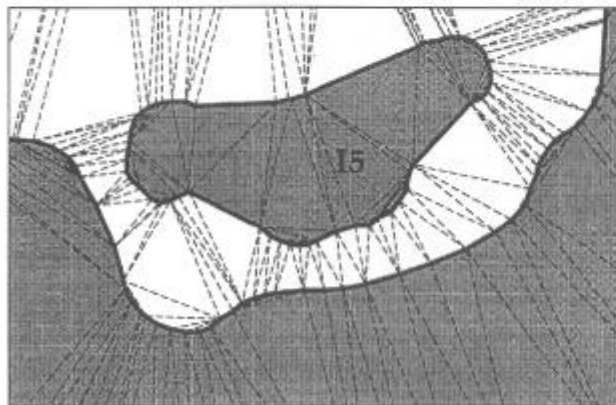
Reclassification - Simplification - Smoothing - **Aggregation** - Displacement -  
Elimination - Enlargement - Exaggeration - Typification - Collapse



a.



b.

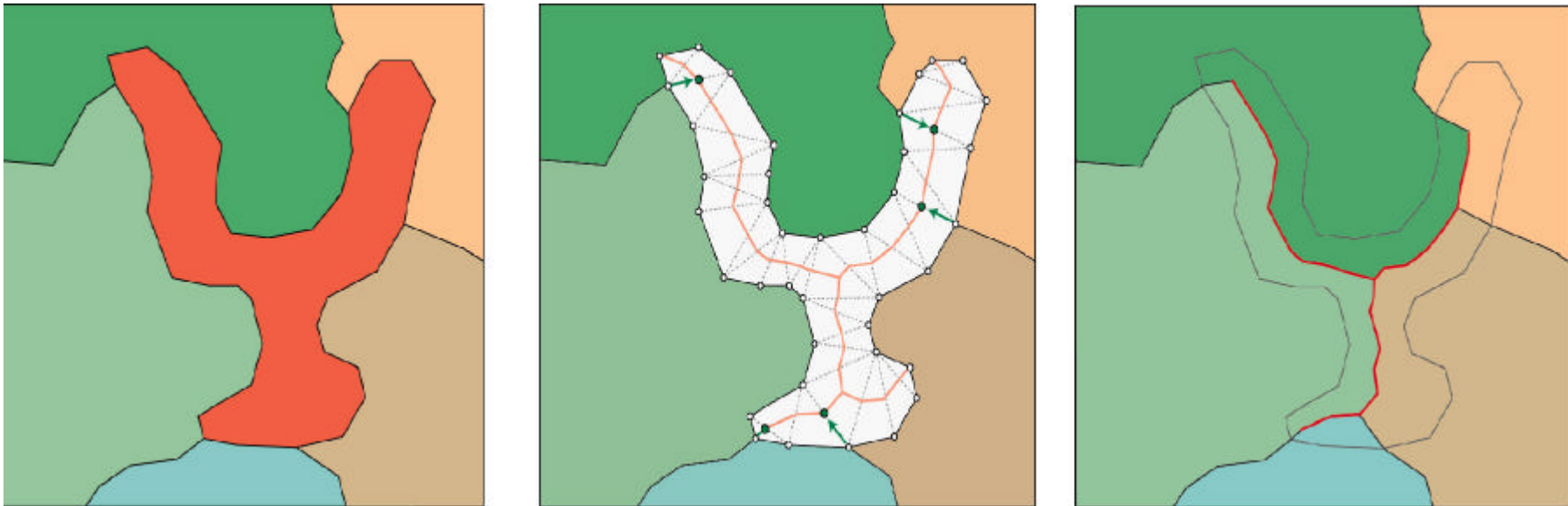


c.

Algorithm for the  
aggregation of polygons  
proposed by Jones et al. (1995).

# Existing algorithms

Reclassification - Simplification - Smoothing - Aggregation - Displacement -  
**Elimination** - Enlargement - Exaggeration - Typification - Collapse



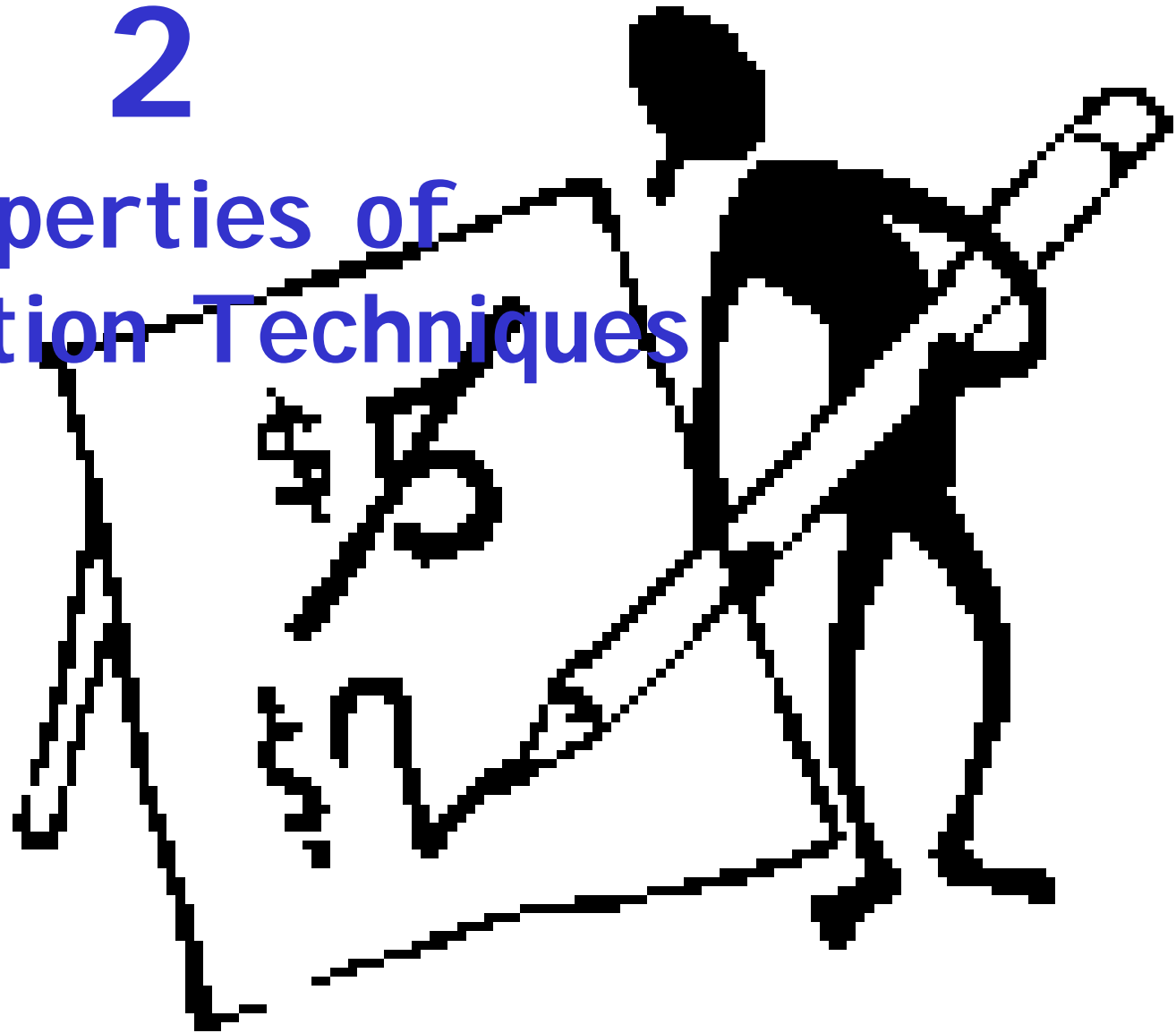
Algorithm for the elimination of a polygon proposed by Bader (1997).

## Existing algorithms - summary

- line-based approaches
- work with few isolated polygons
- merely graphical results
- very specific solutions (data, scale change)
- only geometry considered, semantic neglected
- no coherent and comprehensive approach

# 2

## Properties of Optimization Techniques



# Optimization Techniques (OT)

- well known method in physics and engineering
- determination of a local or global optima of a function
- several approaches already introduced to cartographic generalization:
  - least square (Harrie 1999, Sester 2001),
  - steepest gradient (Ware and Jones 1998),
  - energy minimizing splines (Burghardt a. Maier 1997,  
**Bader 2001**)
  - elastic beams (Bader 2001);

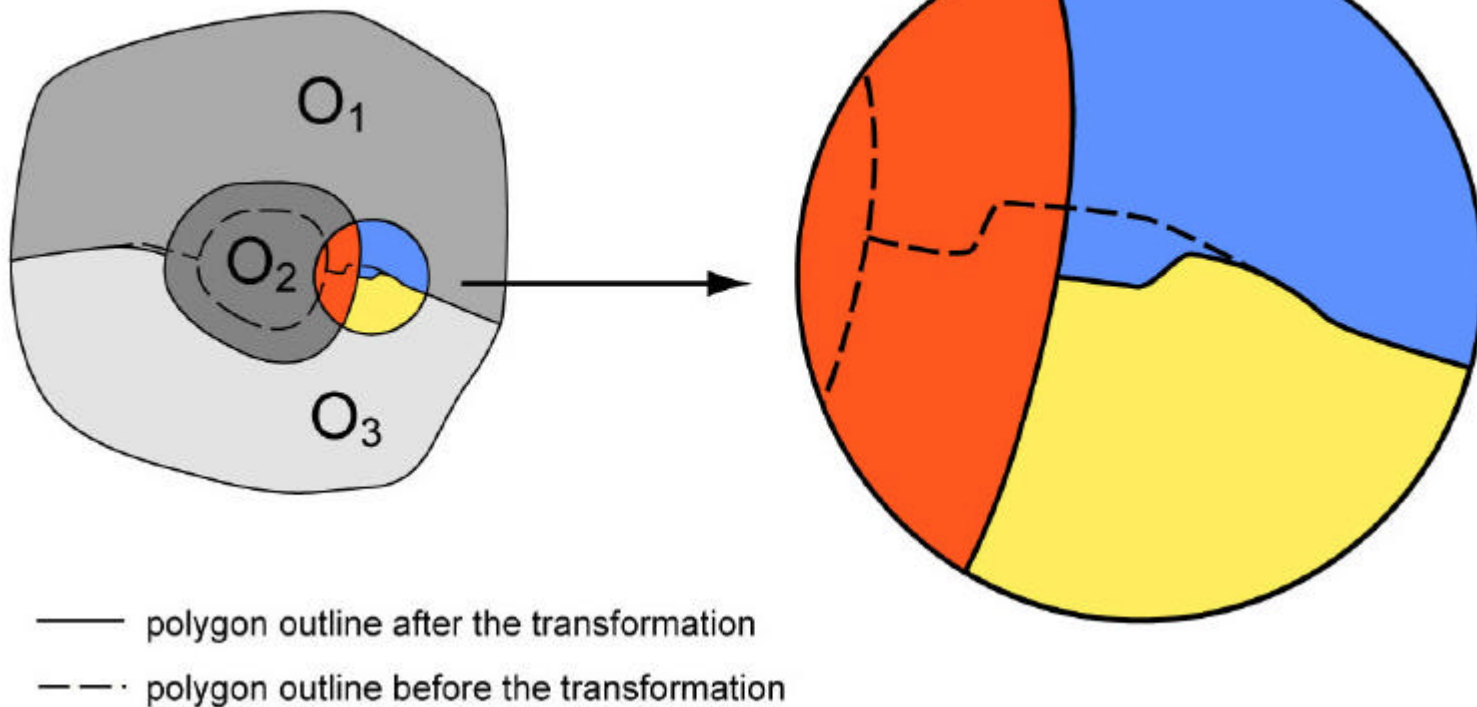
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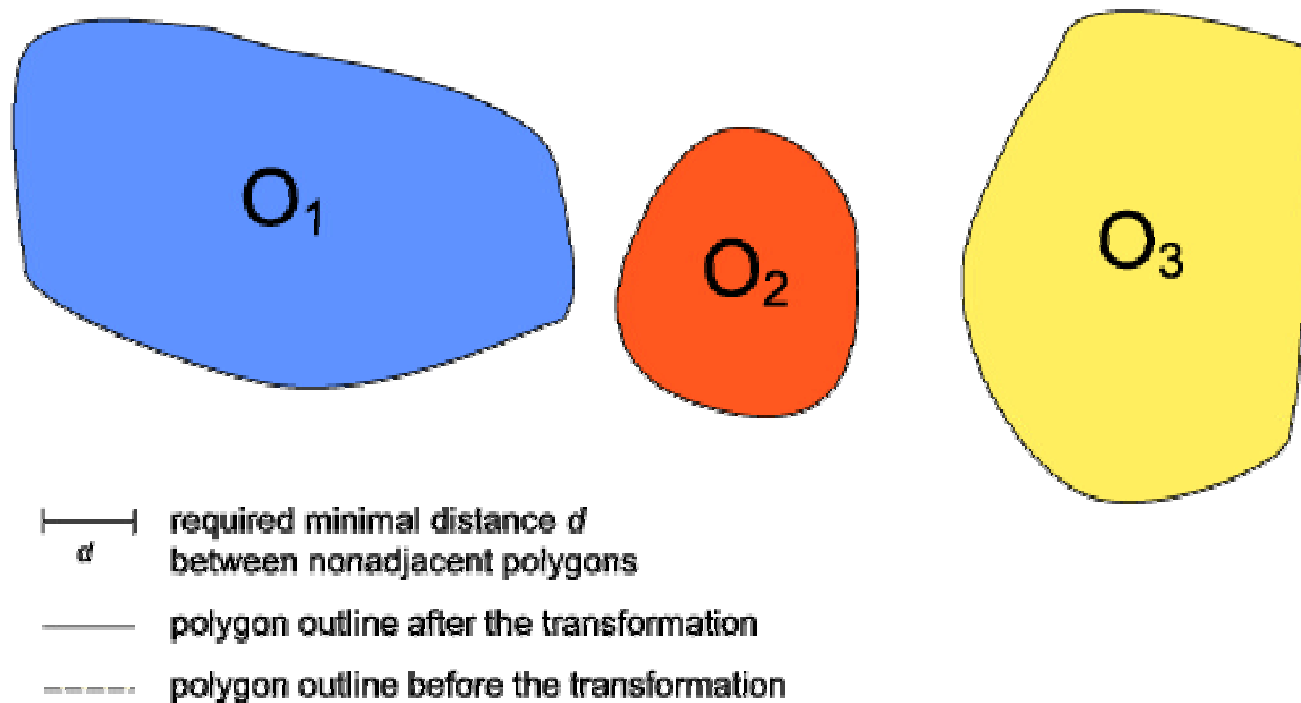
# OT - automated propagation

Enlargement of a polygon and the automated propagation of the displacement at shared nodes.



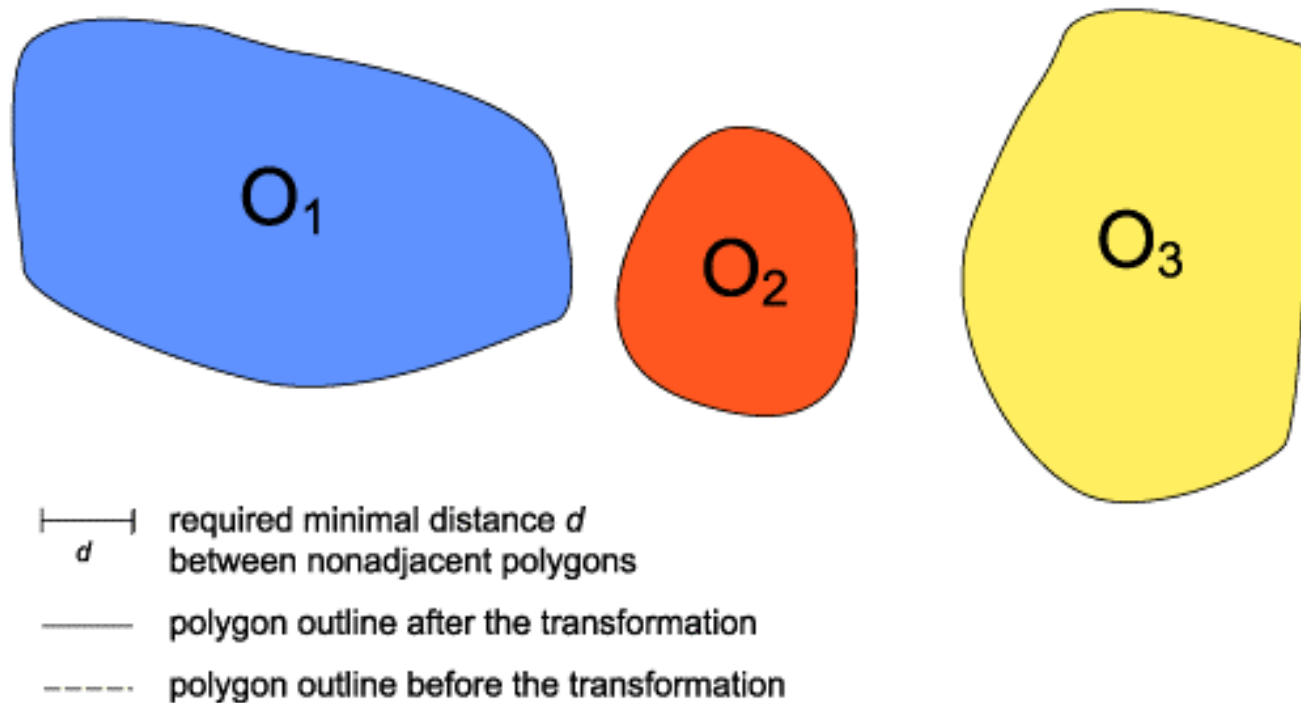
# OT - global generalization approach

Displacement of a polygon and the automated reaction of a nonadjacent neighbor.



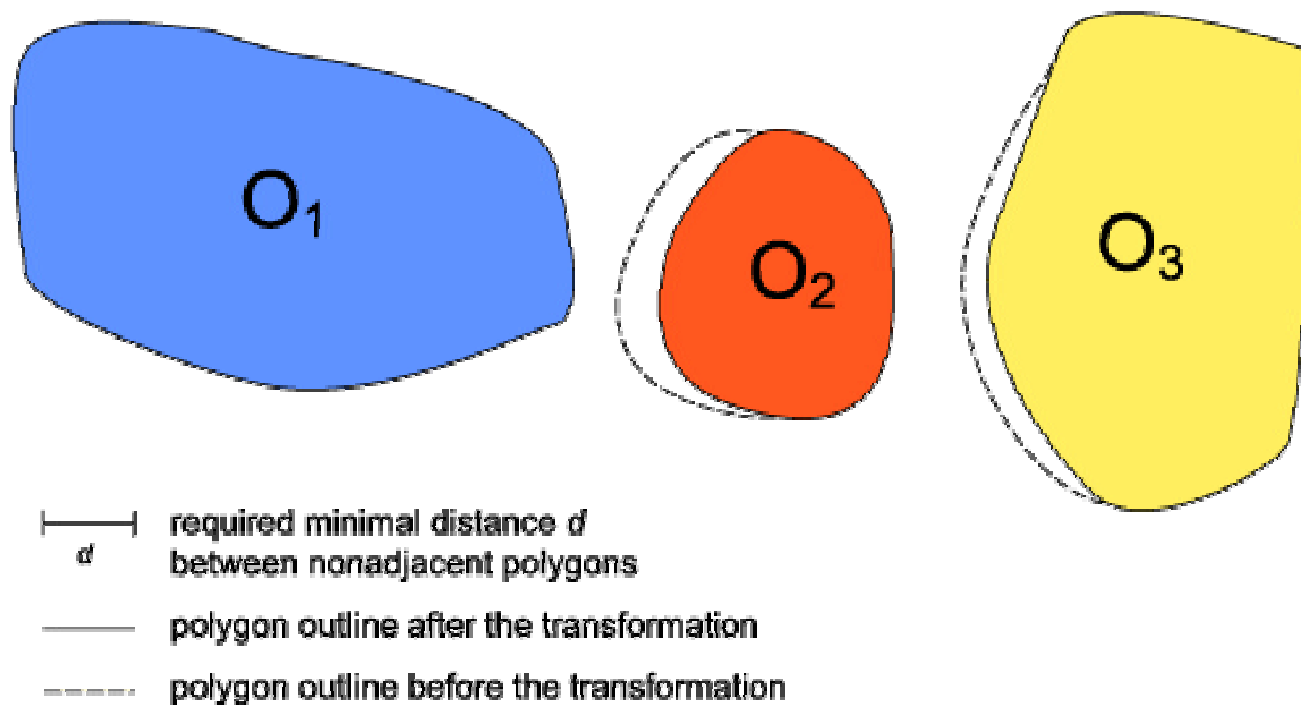
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# OT - global generalization approach

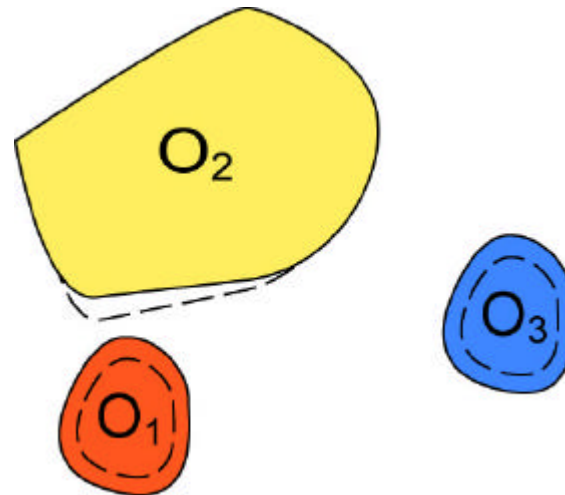
Displacement of a polygon and the automated reaction of a nonadjacent neighbor.

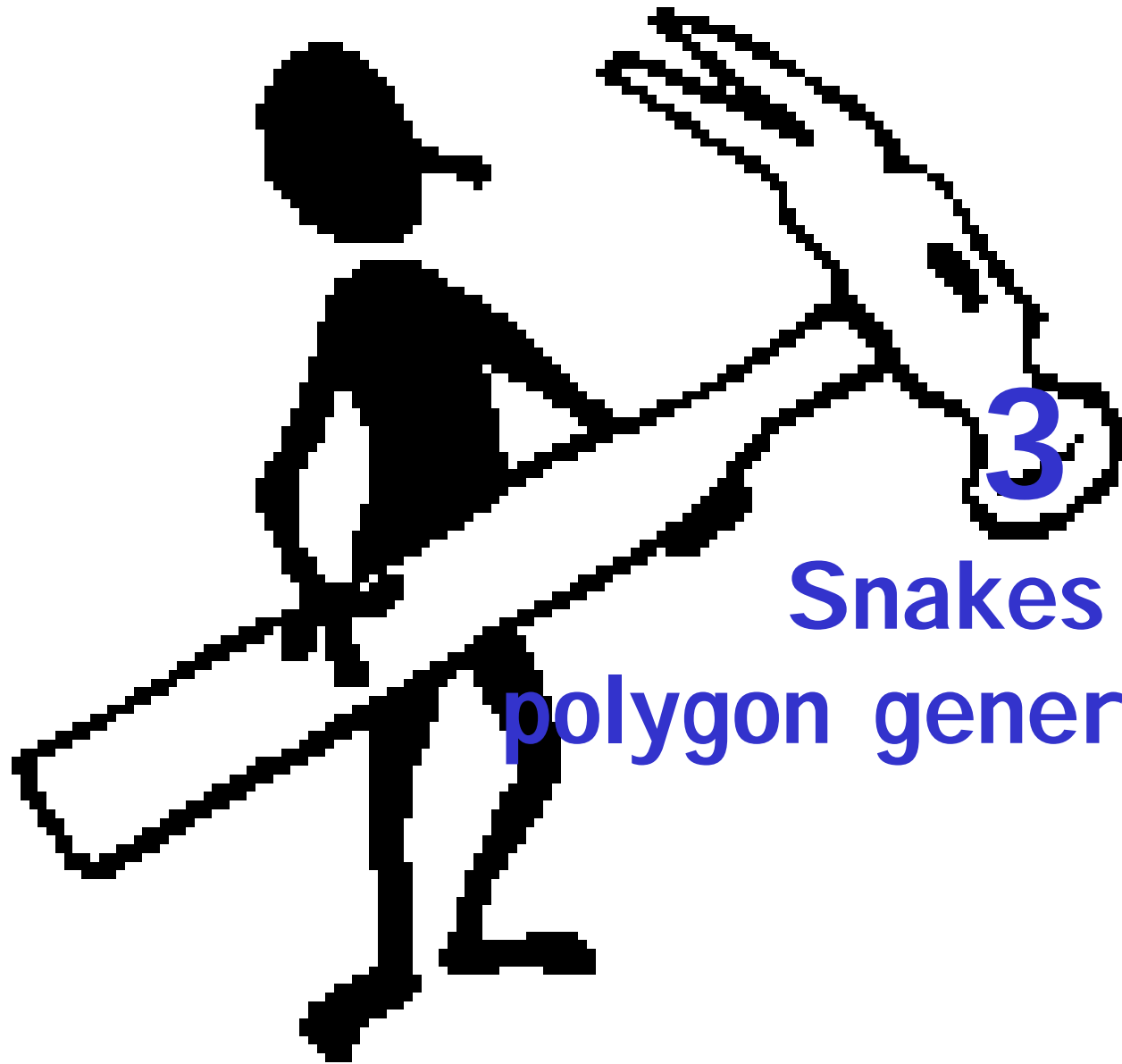


## OT - pros & cons

pros	cons
global approach	parameter setup
automated propagation	computational costs
ease of use	missing concepts
robust	

Enlargement of  $O_1$  vs.  $O_3$  !





## Snakes in polygon generalization

# Snakes, one OT

- iterative energy minimizing spline (Bader 2001)
- compromise between 'power', computational costs, ease of use, cartographic steering
- forces result from cartographic conflicts
- used primarily for line displacement  
(Burghardt 2000, Bader 2001)
- metric conflicts resp. displacement, enlargement and exaggeration of polygons



# Snakes – Parameters

**shape parameters:** **alpha and beta**

define the flexibility of the snake

**iteration term:** **gamma**

defines the inertia of the function

**attraction term:** **psi**

controls the length to cushion a displacement

**flexibility property:** **weight**

controls the objects' activity to solve a conflict.

**force computation:** **force model**

defines forces applied to the objects.

method

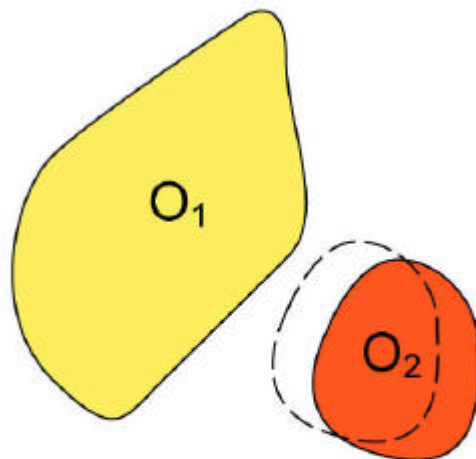
external

# Operators enabled by snakes

varying 'weight' and 'force-model' → different operators

## displacement

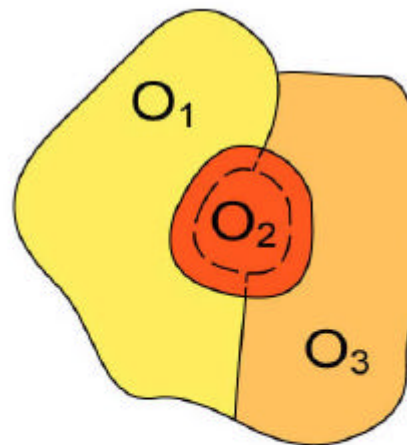
"too near"



	weight	force-model
O <sub>1</sub>	0.	0
O <sub>2</sub>	1.	4

## Enlargement

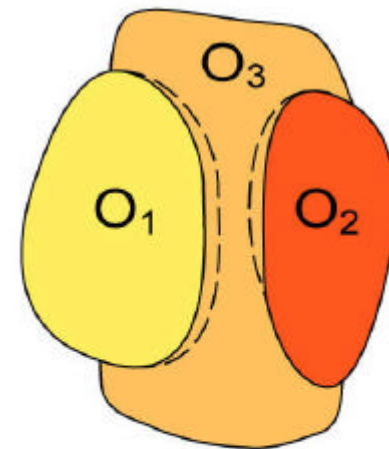
"too small"



	weight	force-model
O <sub>1</sub>	1.	0
O <sub>2</sub>	1.	1
O <sub>3</sub>	1.	0

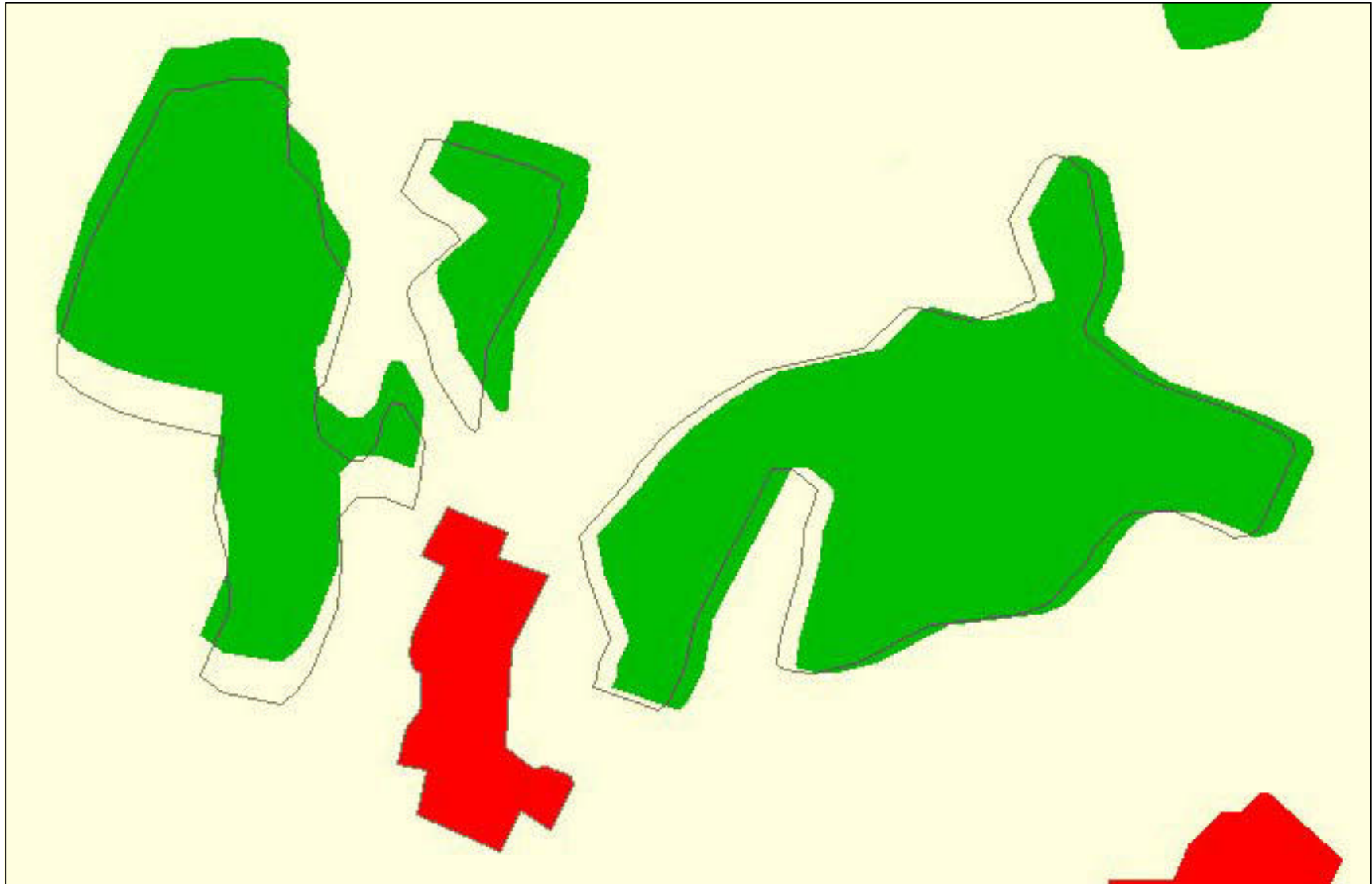
## Exaggeration

"too narrow"

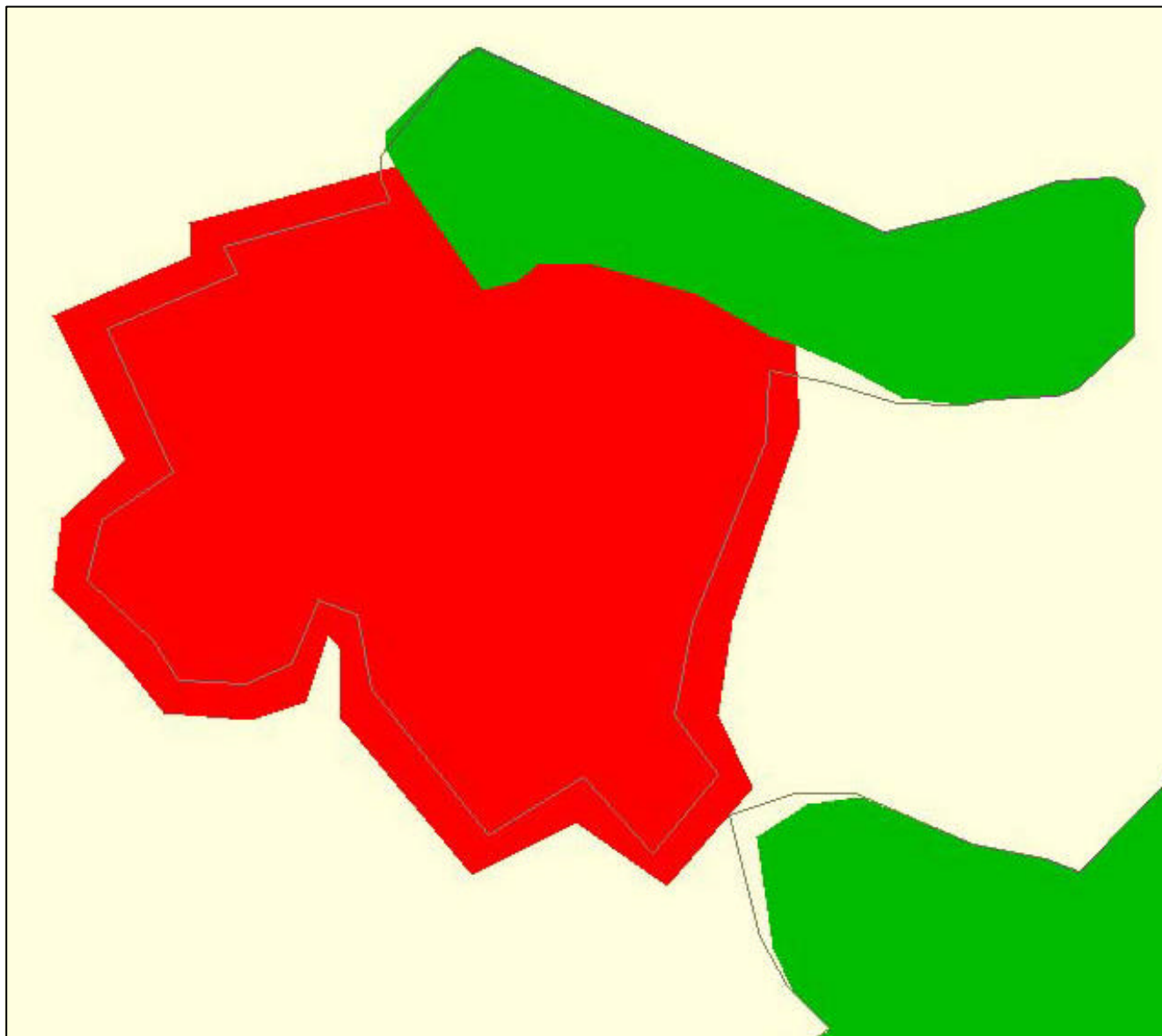


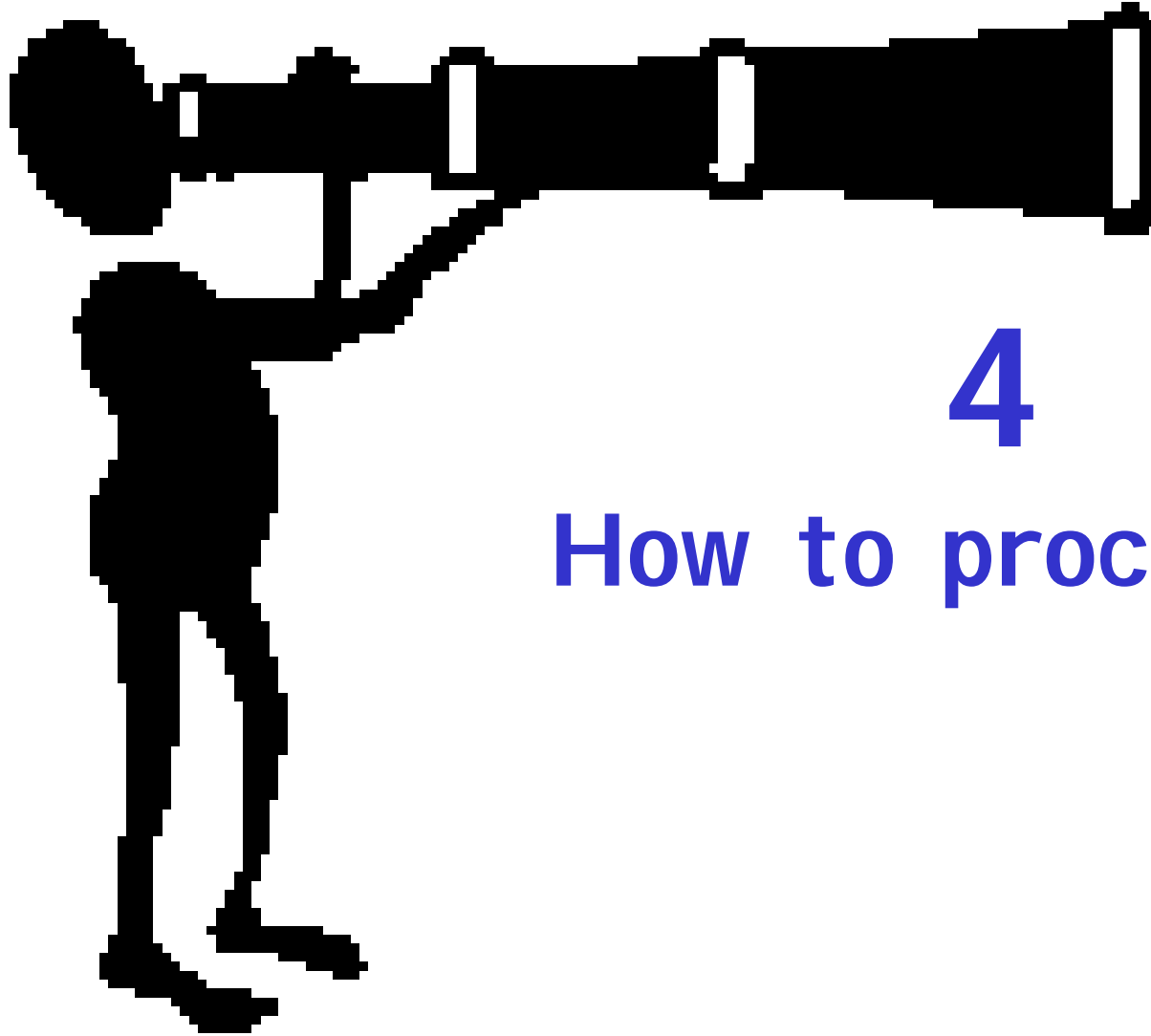
	weight	force-model
O <sub>1</sub>	1.	3
O <sub>2</sub>	1.	3

## Displacement - example with real data



## Enlargement - example with real data





4

How to proceed ...

## **OT (Snakes) for polygon generalization ?**

- powerful and highly flexible method
- shape preservation
- cartographically pleasing results
- numerous extensions resp. refinements thinkable
- concept of force-models and weights proven
- first implementation within Lamps stood the test

# Outlook

- more substantial experiments with snakes  
(different types of data, different scale ranges)
- work on other operators
- semantics triggering geometric transformations
- automated conflict detection (B. Peter)
- experiments with the "AGENT technology"





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