

# Geometry-Type Change in Model Generalization

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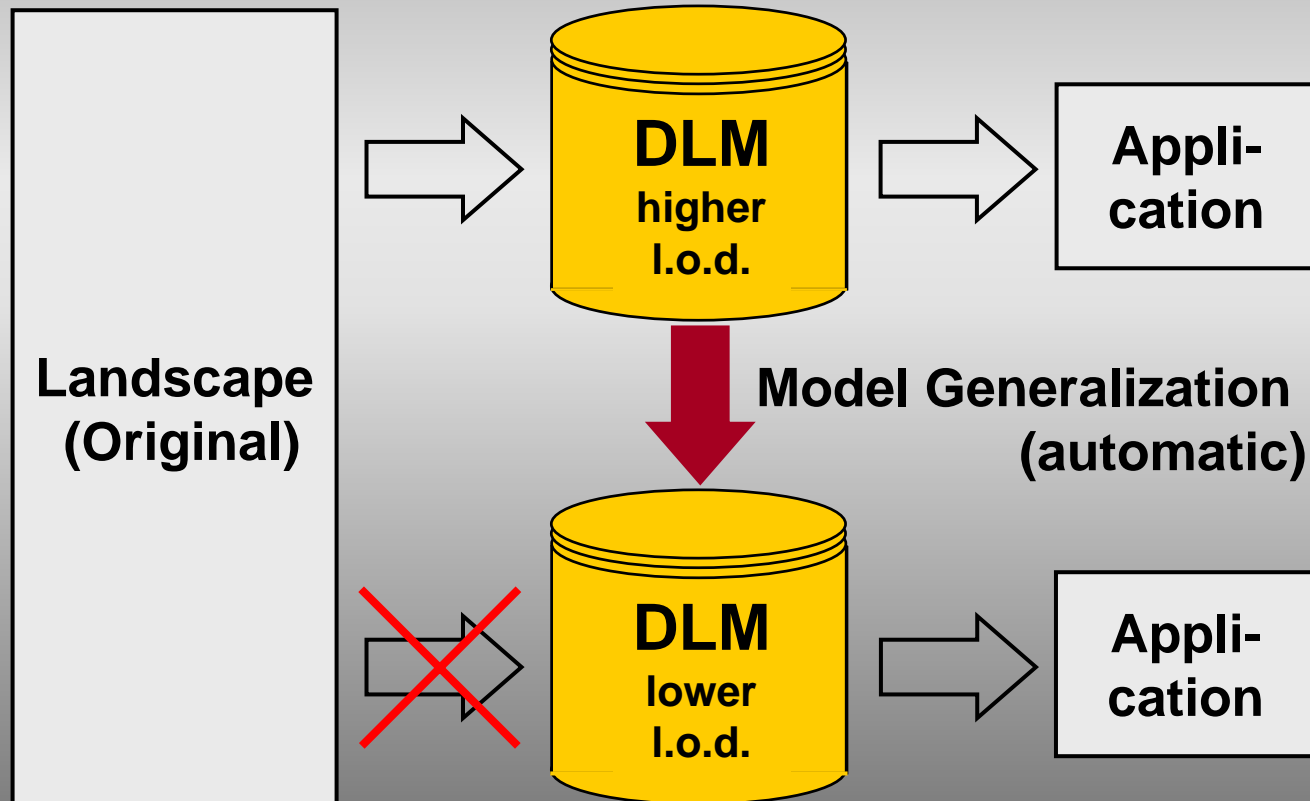
*ISPRS / ICA Workshop Joint Workshop on Multi-Scale  
Representations of Spatial Data Ottawa, July 7-8, 2002*

# Overview

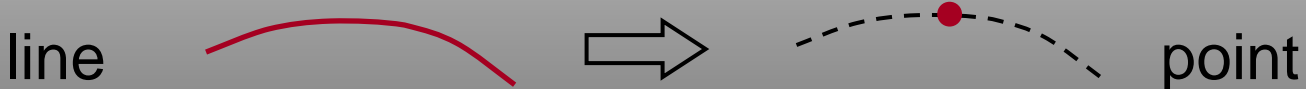
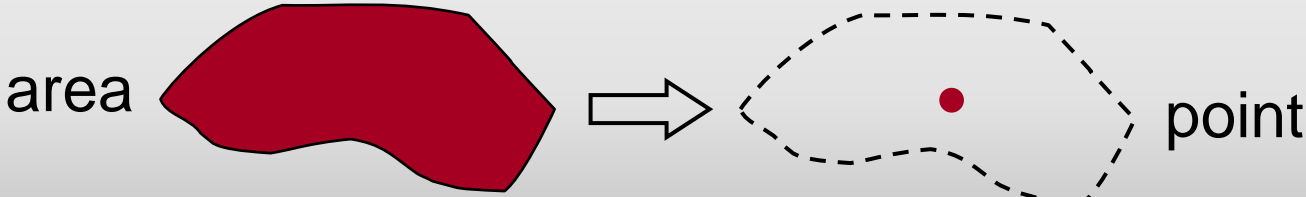
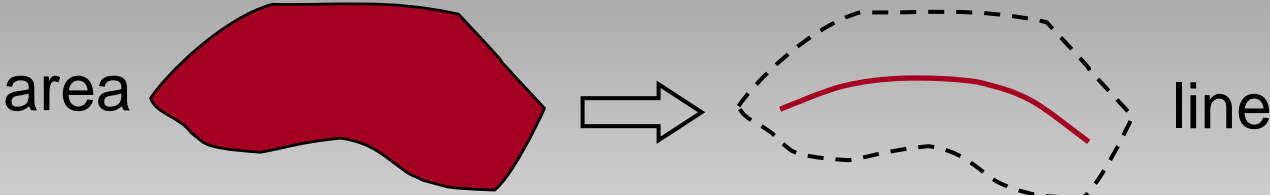
1. Model Generalization
  2. Geometry-Type Change
  3. Purely Geometrical Algorithms
  4. Data Model
  5. Topological Shrinking
  6. Conclusion
- } (Introduction)
- (Problem)
- } (Our Approach)

# Model Generalization

DLM: Digital Landscape Model -  
Alphanumeric Description of Landscape



# Geometry-Type Change



# Geometry-Type Change

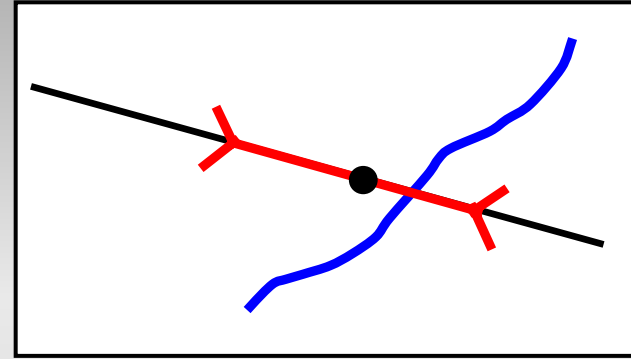
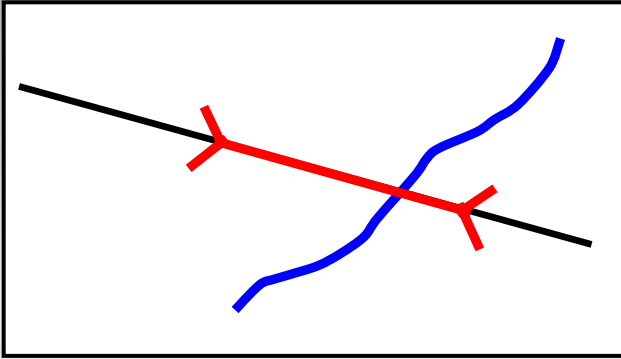
## Algorithms:

- Area  $\rightarrow$  Line:
  - Skeleton
  - Medial Axis
  - Voronoi Diagrams
- Area  $\rightarrow$  Point:
  - Centroid
  - Mean Centre
  - Bounding Rectangle
- Line  $\rightarrow$  Point:
  - Centre Point
  - Weighted Centre Point

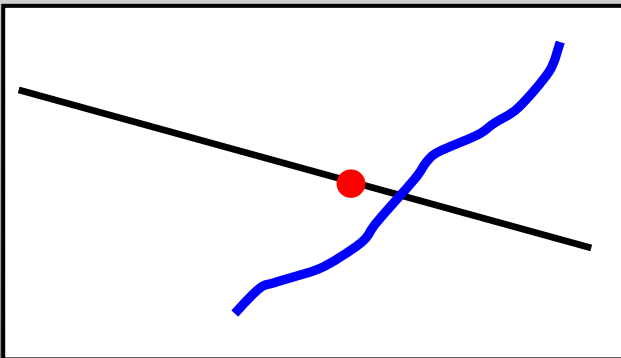
$\Rightarrow$  "Purely Geometrical Algorithms"

# Example 1: Bridge

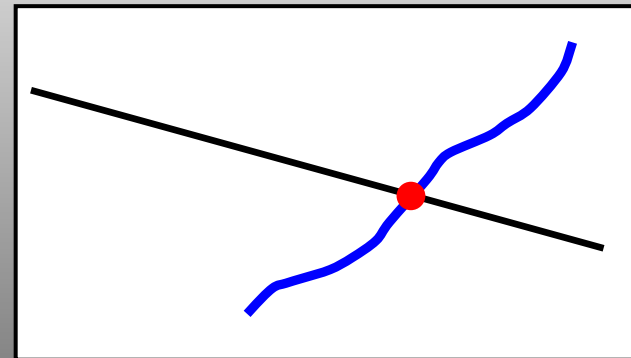
line  $\rightarrow$  point



Purely Geometrical Algorithm

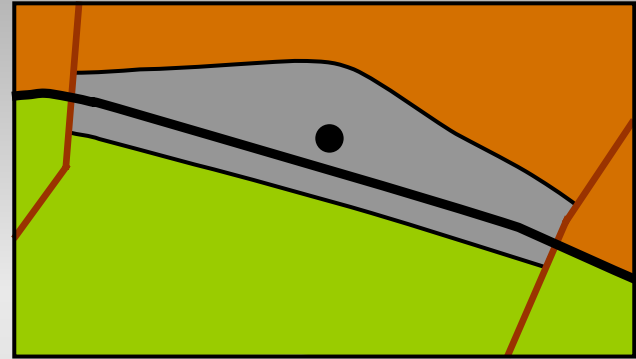
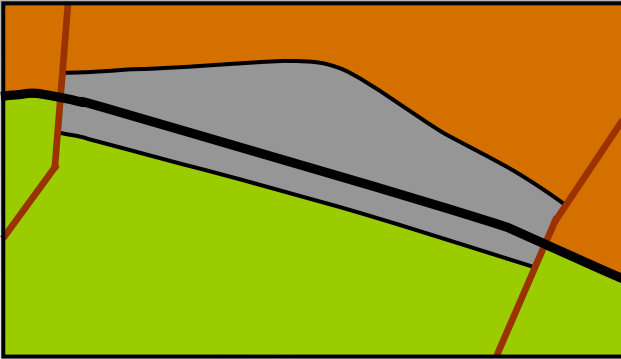


Desired Result

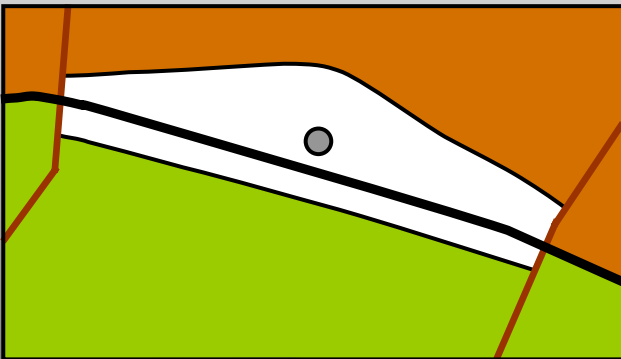


# Example 2: Railway Station

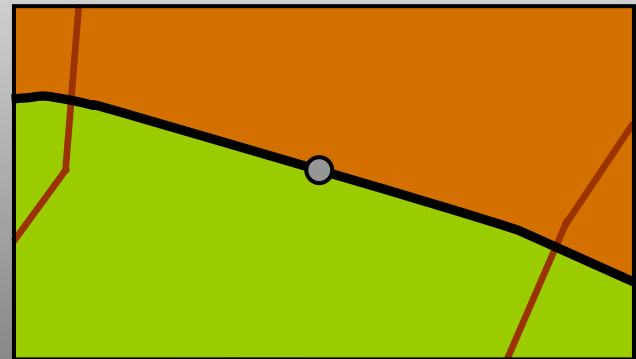
area  $\rightarrow$  point



Purely Geometrical Algorithm



Desired Result

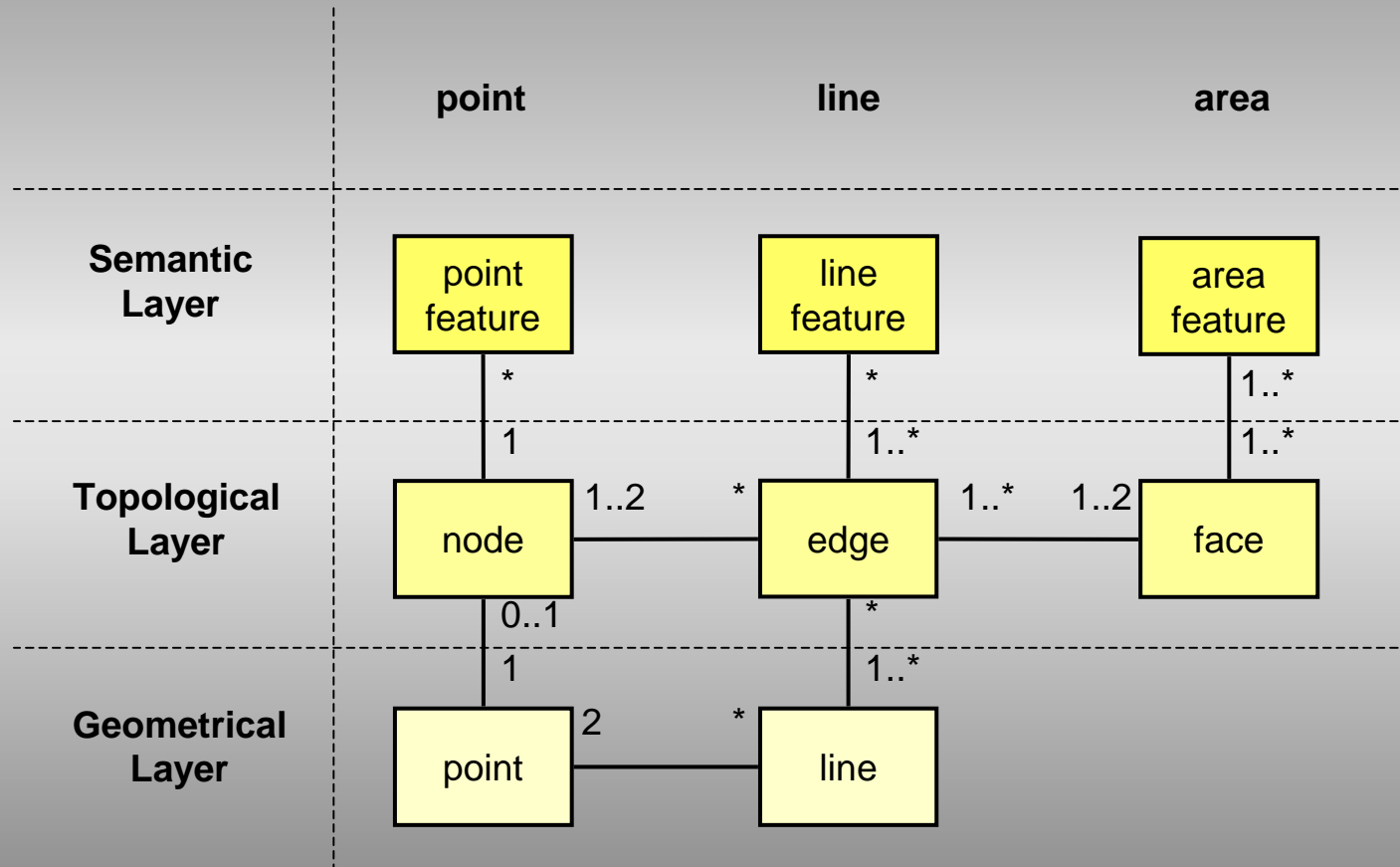


# Purely Geometrical Algorithms

Observations from the examples:

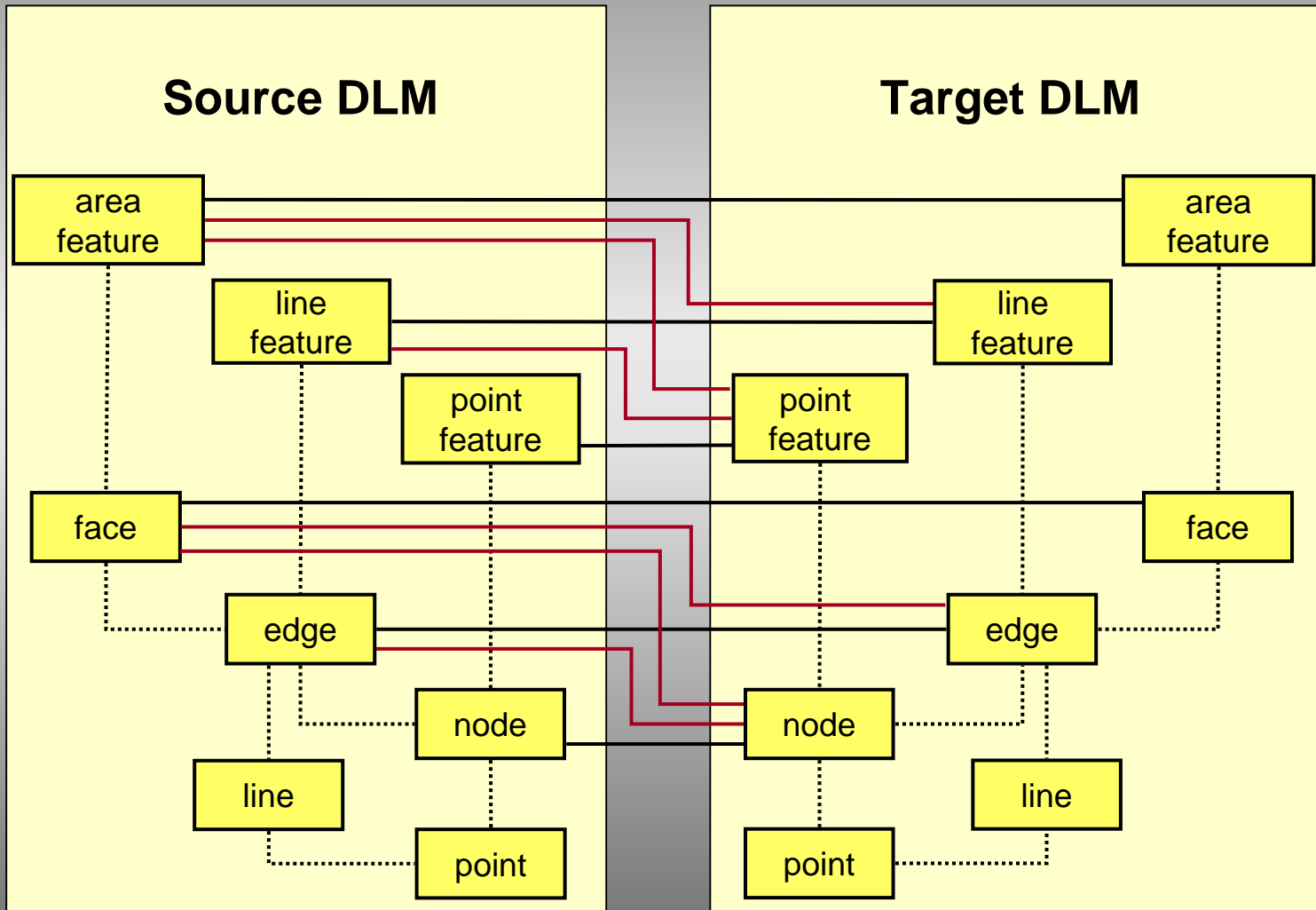
- **Topological relations** must be obeyed
    - bridge  $\leftrightarrow$  river
    - railway station  $\leftrightarrow$  railway track
  - **Area** must be **covered** completely
- $\Rightarrow$  **Purely Geometrical Algorithms** disobey these properties

# Data Model



Notation: UML

# Data Model

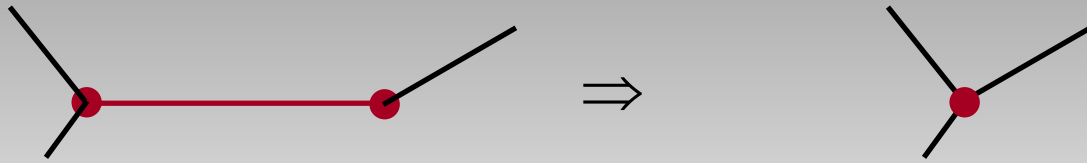


# Topological Shrinking

- Key idea: shrink topological elements to its desired form  
face  $\rightarrow$  edge      edge  $\rightarrow$  node
- Two-step calculation:
  1. Determination of **target topology**
  2. Shrinking of topological elements  
via a series of **merging operations**

# Merging Operations

1.

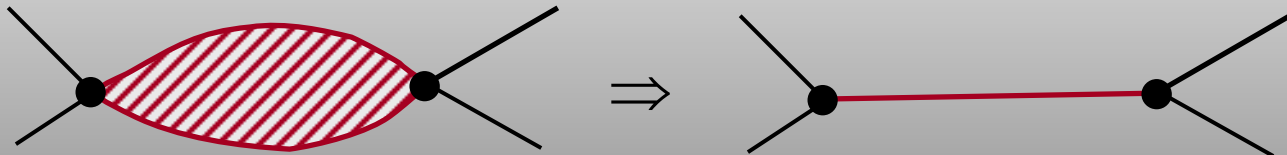


2 nodes  
1 edge

$\Rightarrow$

1 node

2.



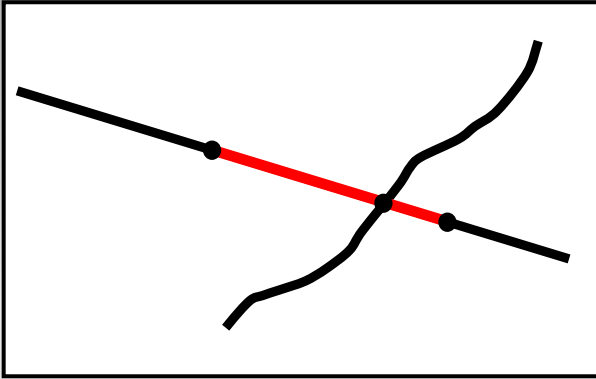
2 edges  
1 face

$\Rightarrow$

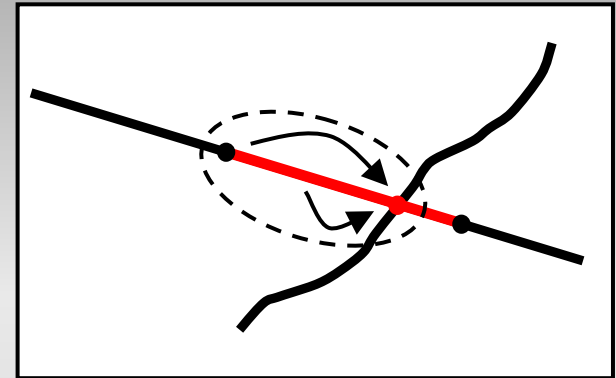
1 edge

# Topological Shrinking: Bridge

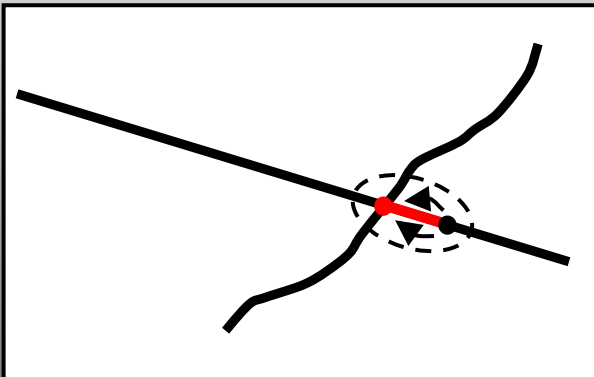
Determination of Target Topology



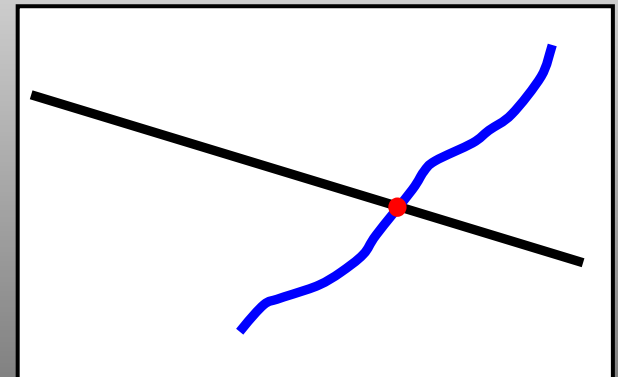
Merging (1)



Merging (2)

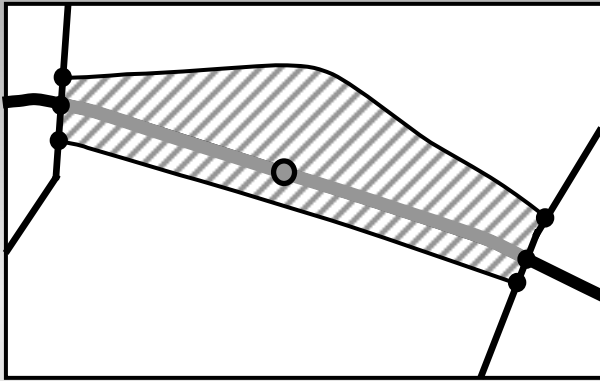


Resulting Situation

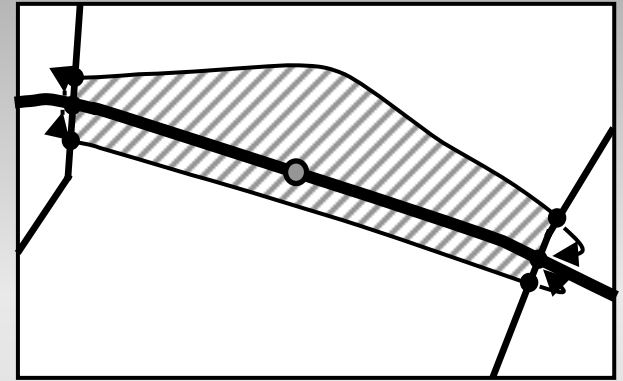


# Topological Shrinking: Station

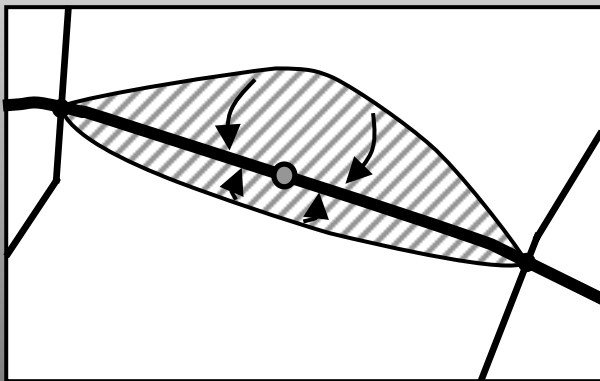
Determination of Target Topology



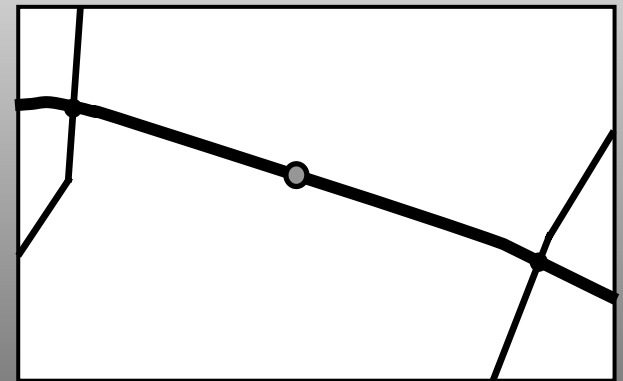
Merging of nodes



Merging of edges



Resulting Situation



# Topological Shrinking

- **Determination of target topology:**
  - Dependence on semantics
  - Classification of geometry-type changes:
    - Vertical reference (bridge → river)
    - Inner topology (station → railway track)
    - Outer topology
    - Geometry
- **Shrinking of topological elements**
  - Order of merging operations  
(station: 1. nodes 2. edges)
  - Dependence on topology

# Conclusion

- Properties that must not be violated:
  - Topological Relationships
  - Area Covering
- Purely Geometrical Algorithms may destroy these properties
- Data Model: topology modelled explicitly
- Topological Shrinking preserves the above properties
- Geometry-Type Change:  
More a topological problem than a geometrical one