Querying GIS with Animated Spatial Sketches

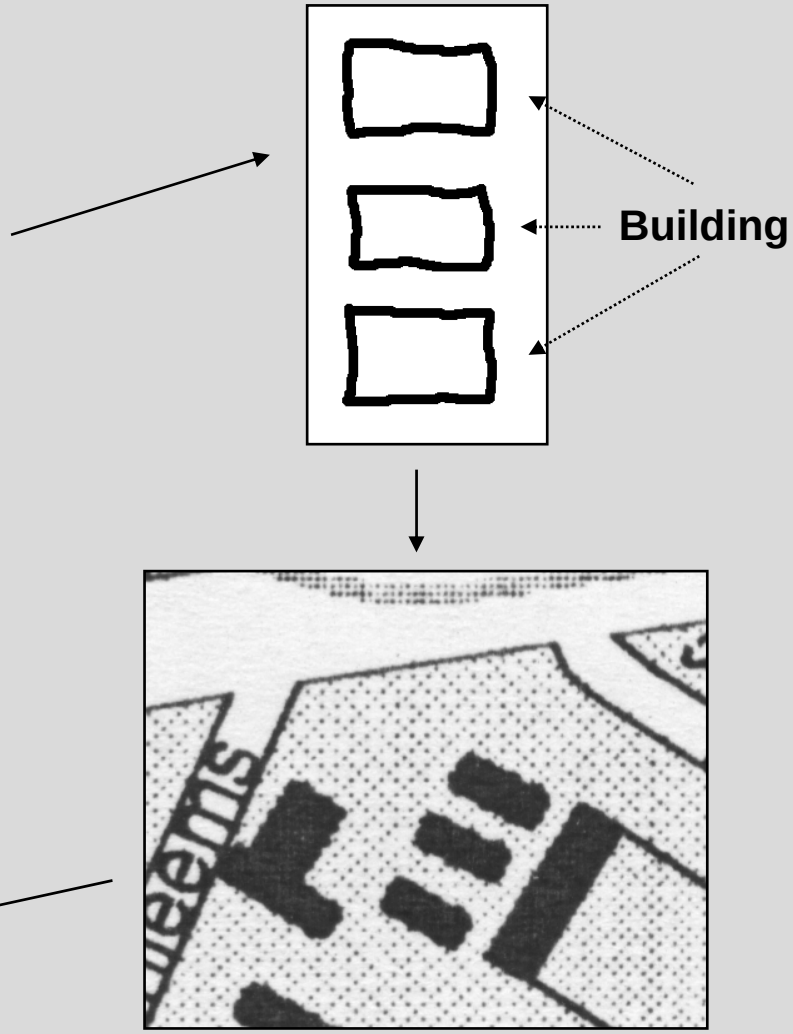
Volker Haarslev and Michael Wessel
University of Hamburg, Germany
haarslev@informatik.uni-hamburg.de
http://kogs-www.informatik.uni-hamburg.de/~haarslev/

- Motivation
- VISCO's Language Elements
- Sketching Queries for City Map Examples
- Conclusion
- (Demo Slides)

Motivation

Query Spatial Databases (GIS)

- Sketch constellation of spatial objects
  - **Topological** and **geometric relationships** between components are important
- Consider relationships in sketches as query constraints
- Interpret sketch as “sentence” of a visual query language



Explicit Meta Information

- Relaxation of geometrical (topological) constraints needed
- Derived constraints (e.g. centered)

Naive Physics Metaphor

Semantics of Query Objects

Physical properties visualize semantics

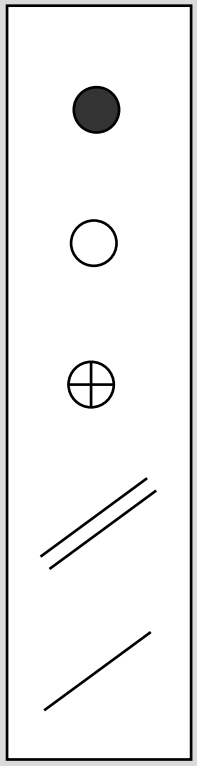
- **0-D**: marbles, nails, swivel joints
  e.g. marble: roll around, change position
- **1-D**: (cross) beams, rubber bands, telescop antenna
  e.g. rubber band: stretch, shrink, wrap around
- **2-D**: enclosures, transparencies
  e.g. enclosure: fenced area trapping marbles

Vivid
Spatial
Constellations

Animation

- Degrees of freedom gained by relaxations
- Variations of user sketches visualized by animations

VISCO's Language Elements



Fixpoint

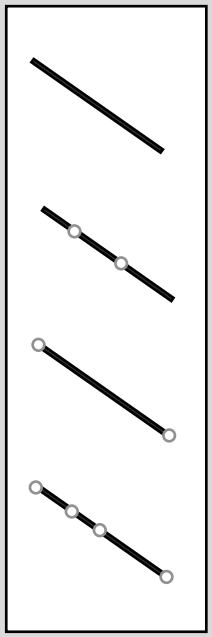
Marble

Nail

Beam

(Atomic)
Rubber Band

Crossbeams



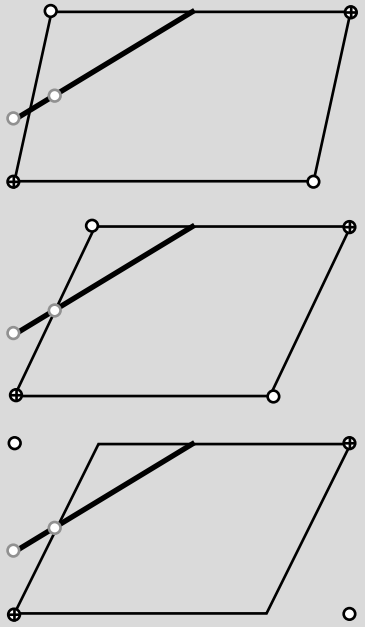
Fixed Angle

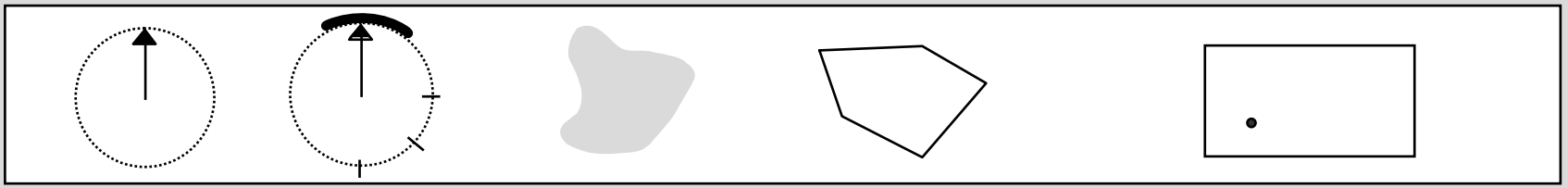
Minimal Angle

Maximal Angle

Min + Max Angle

Parallelogram
as example



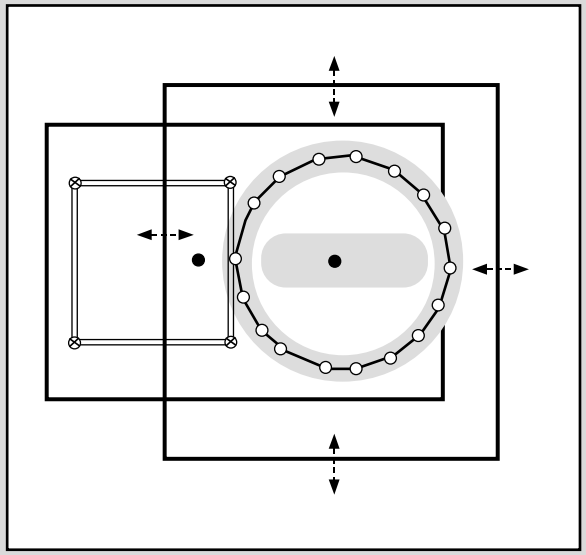


Compass Enclosure Polygon Transparency Film

VISCO: Transparency Films

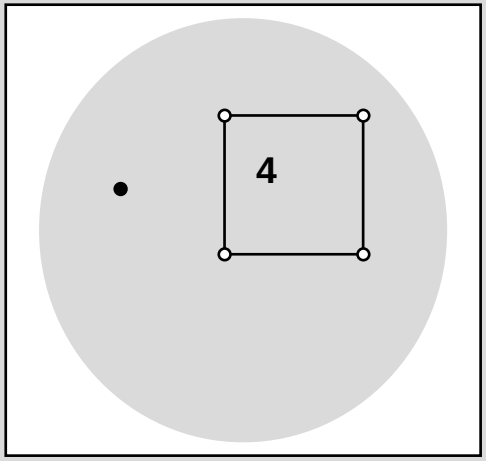
Basic Building Block

- Transparency film (of an overhead projector)
  - Rectangular shape
  - Own local cartesian coordinate system
  - Can be scaled, translated, rotated, and stacked up
  - Fixpoint (w.r.t. transformations) is required
    - Any nail (isolated or as vertex) on transparency
- Users interactively draw VISCO's query elements
- Collection of drawn elements defines (sub)constellation
  - Geometrical and topological relationships are relevant

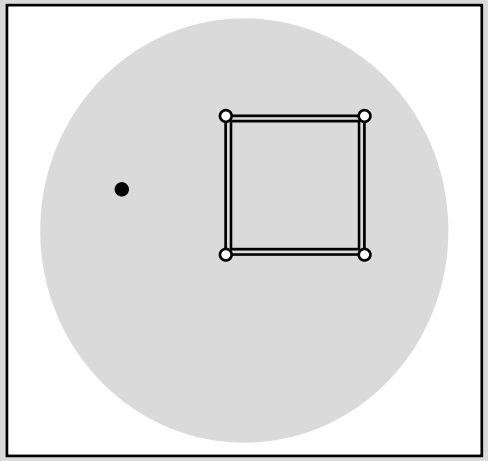


- One transparency as drawing sheet
- Two transparencies each with objects

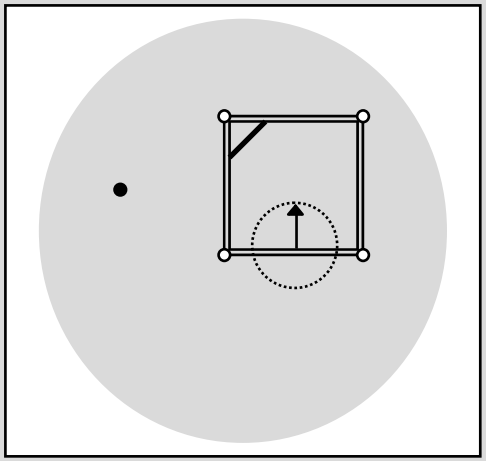
Example: Various Quadrilaterals



- matches at most 4 line segments
- marbles act as swivel joints and may float inside of enclosure
- rubber bands may stretch or shrink



- 4 beams as edges
- marbles act as swivel joints and may float inside of enclosure
- beams have a fixed length



- 4 beams as edges
- marbles may float inside of enclosure
- beams have a fixed length and a fixed right angle
- fixed orientation

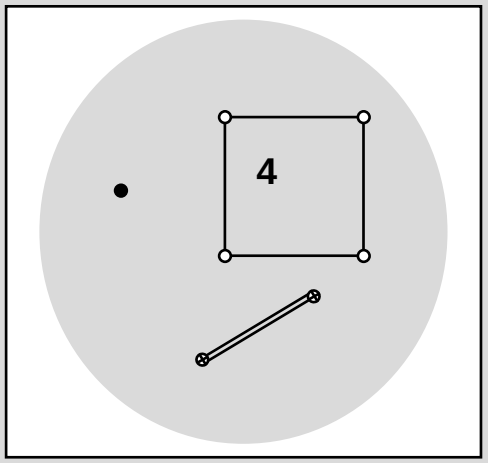
VISCO: Enclosures and Points

Enclosure

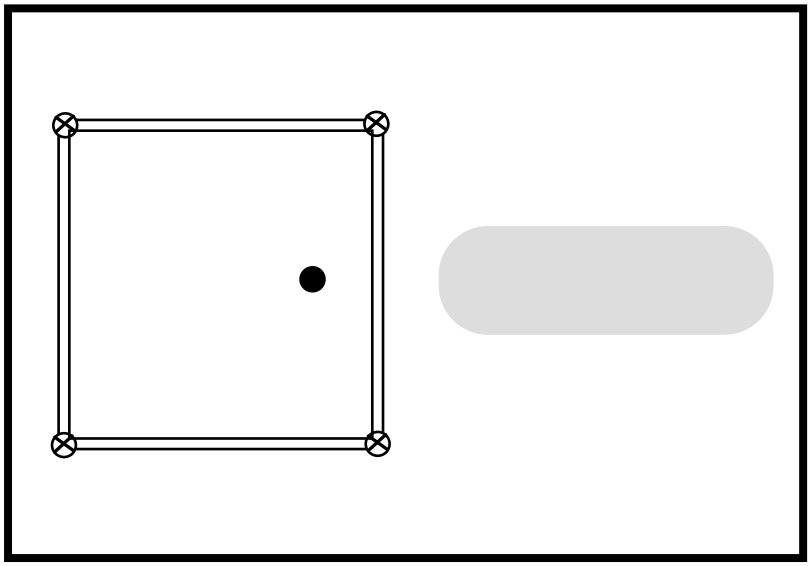
- Enclosure is meta object
  - visualized by a gray texture
  - all enclosed objects are "trapped" and must stay inside of their enclosure
- Two types of enclosures
  - **translucent**: also consider relationships with other visible objects
  - **opaque**: hidden objects are excluded
- Computed ε-enclosures
  - interior or exterior (border) of an object
  - radius is required

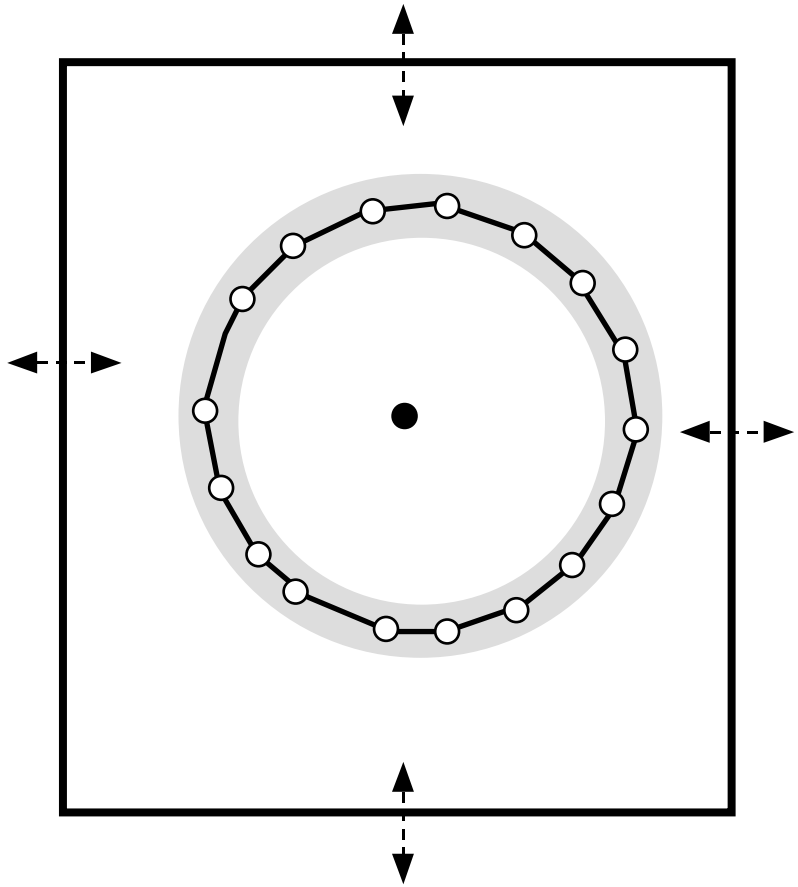
Point

- Semantics of nails not affected
- Marbles are only allowed inside of enclosures
- Marbles may freely change their position

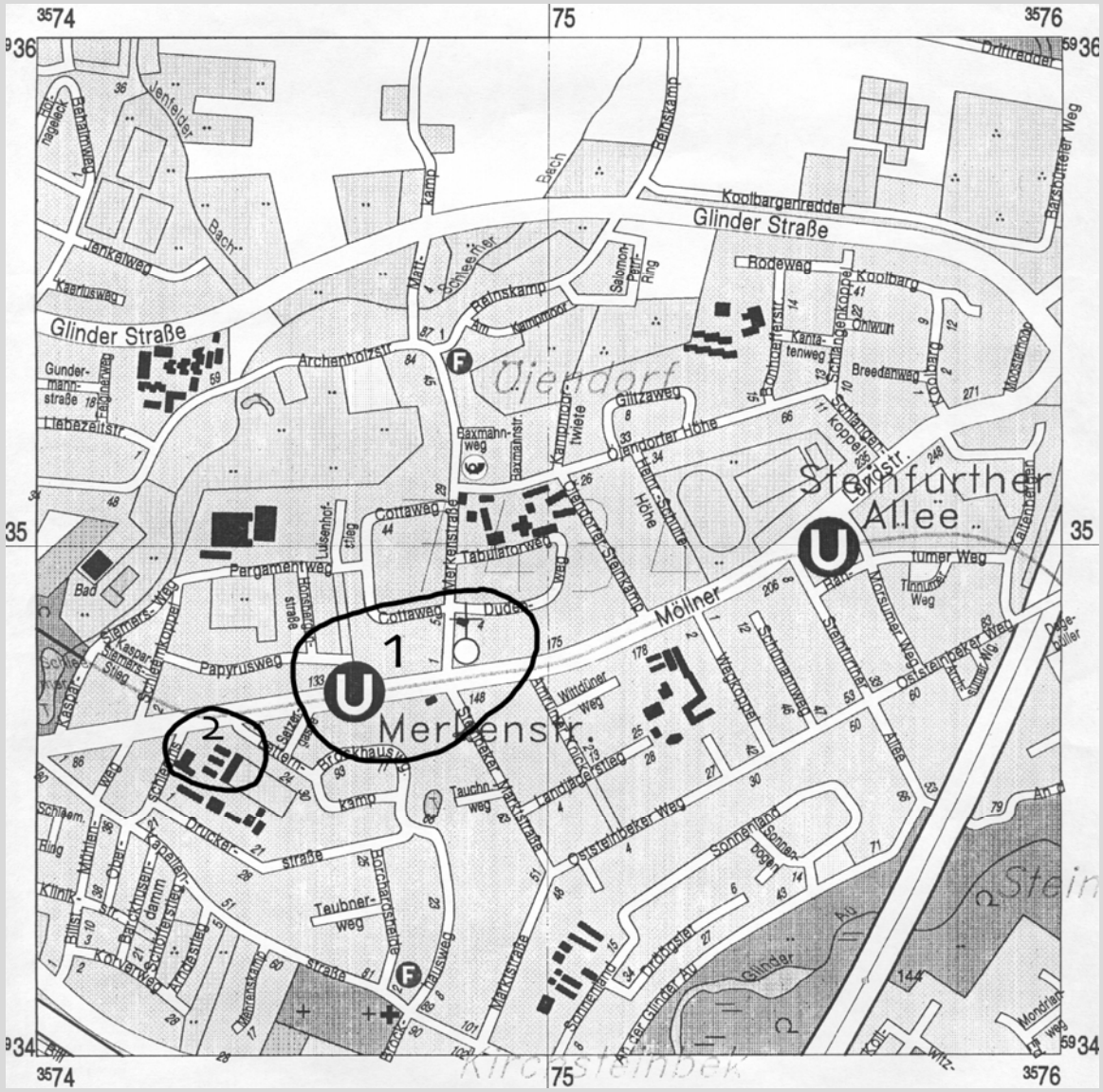


Example: Rectangle Touching Scalable Circle





City Map Example: Öjendorf as Subsection of Hamburg



- Areas intended as query matches are marked
- Input for query processing is a vector representation of this map

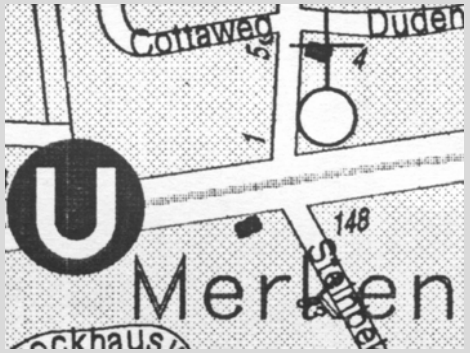
Map data donated by the 'Amt für Geoinformation und Vermessung'

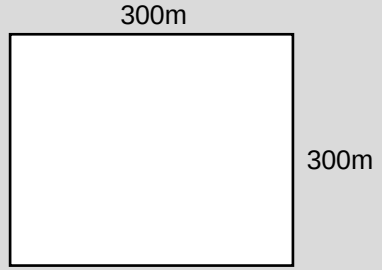
Volker Haarslev, September 97

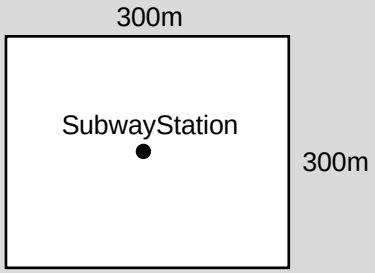
City Map Example: Church in vicinity of subway station

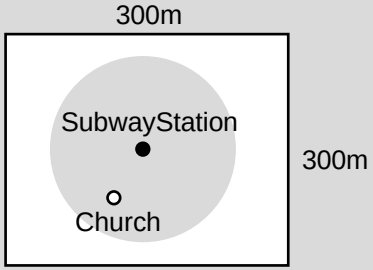
Snapshots of query construction with example of intended match

- Create transparency of fixed size (300 x 300 m)
- Draw a fixpoint (nail) and attach the concept *'SubwayStation'* to fixpoint
  - fixpoint may coincide with any point object in database
- Generate circular ε-enclosure
  - fixpoint as center
  - radius of 100 m
- Draw a marble inside of the enclosure and attach the concept *'Church'* to marble

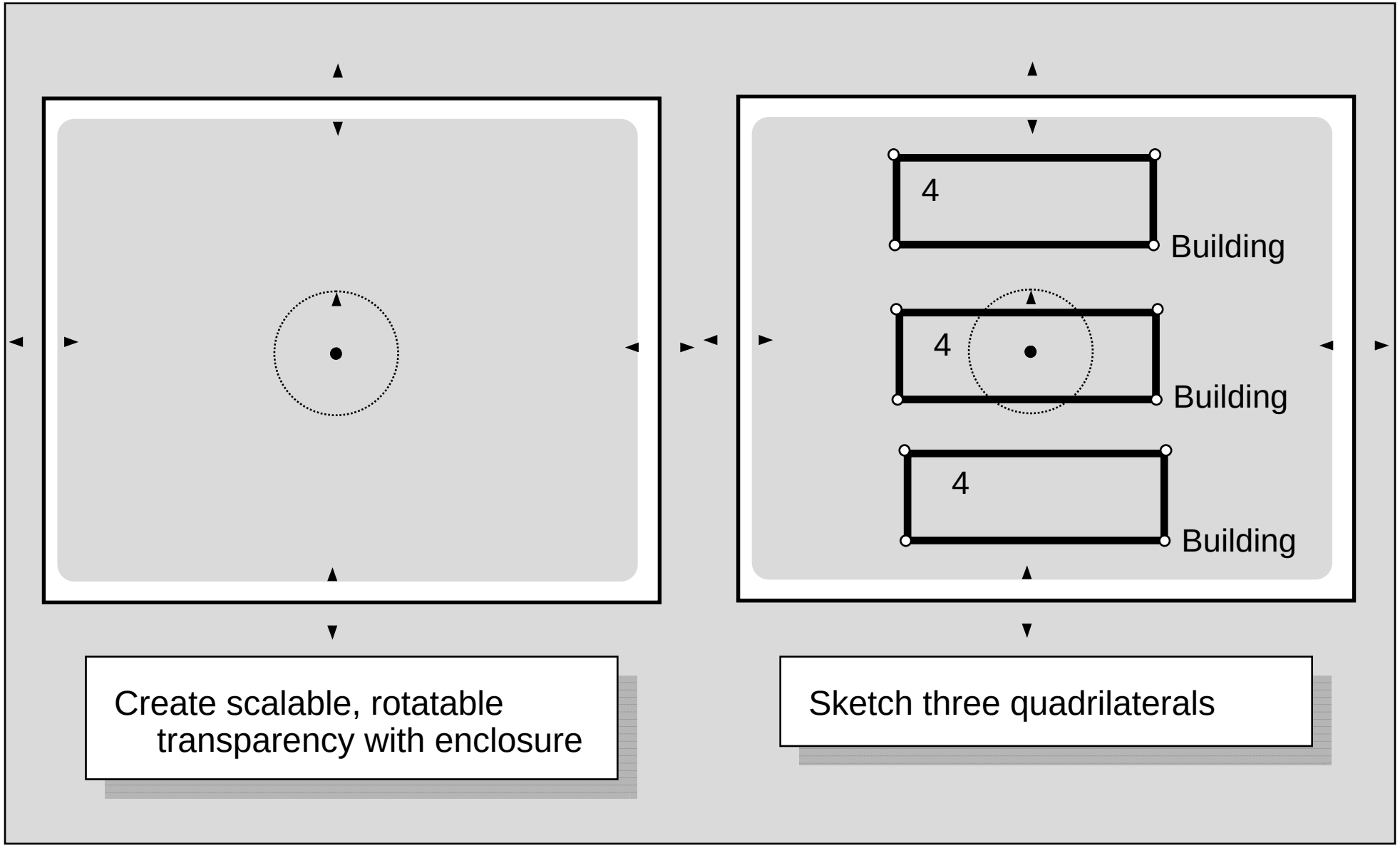




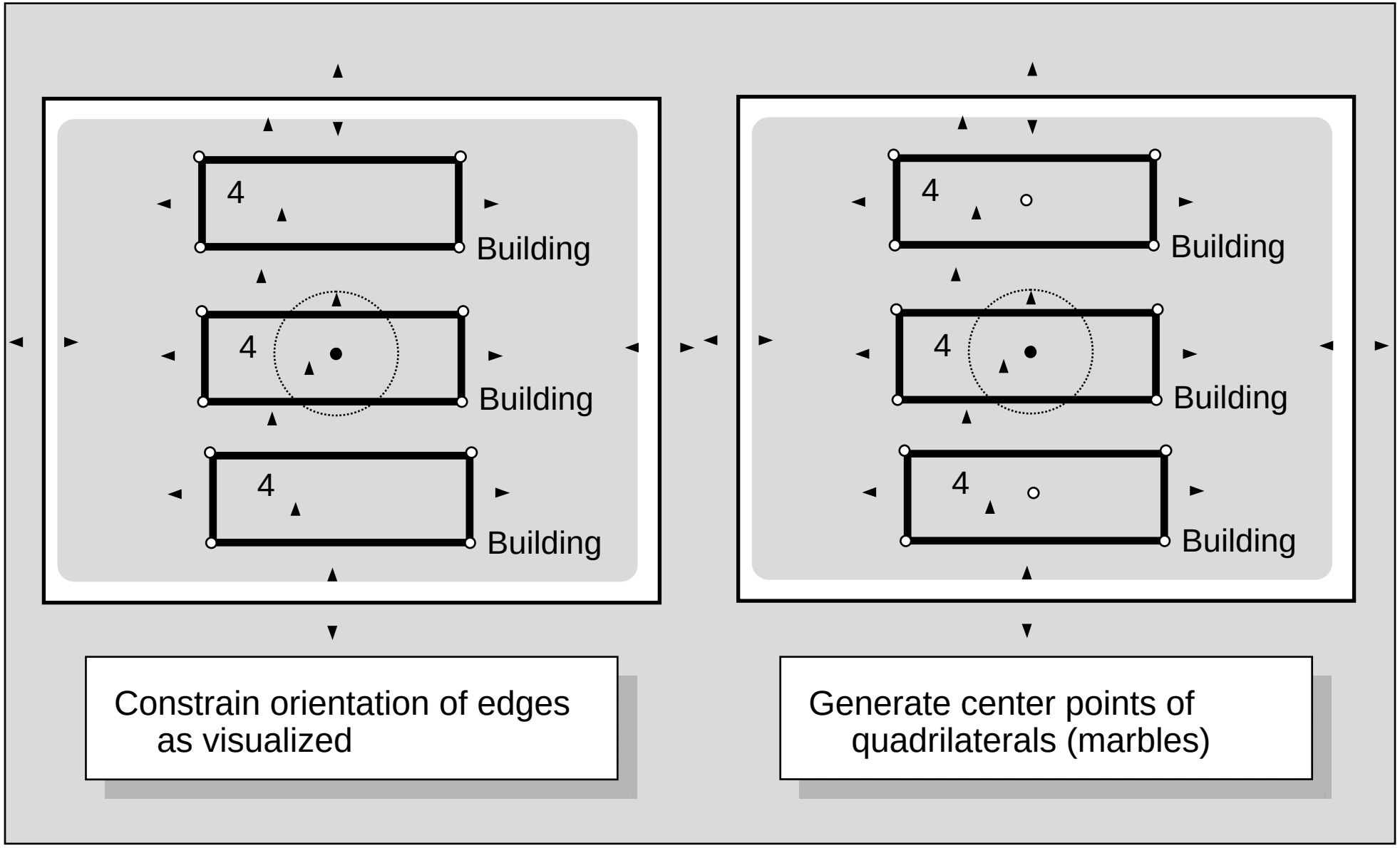




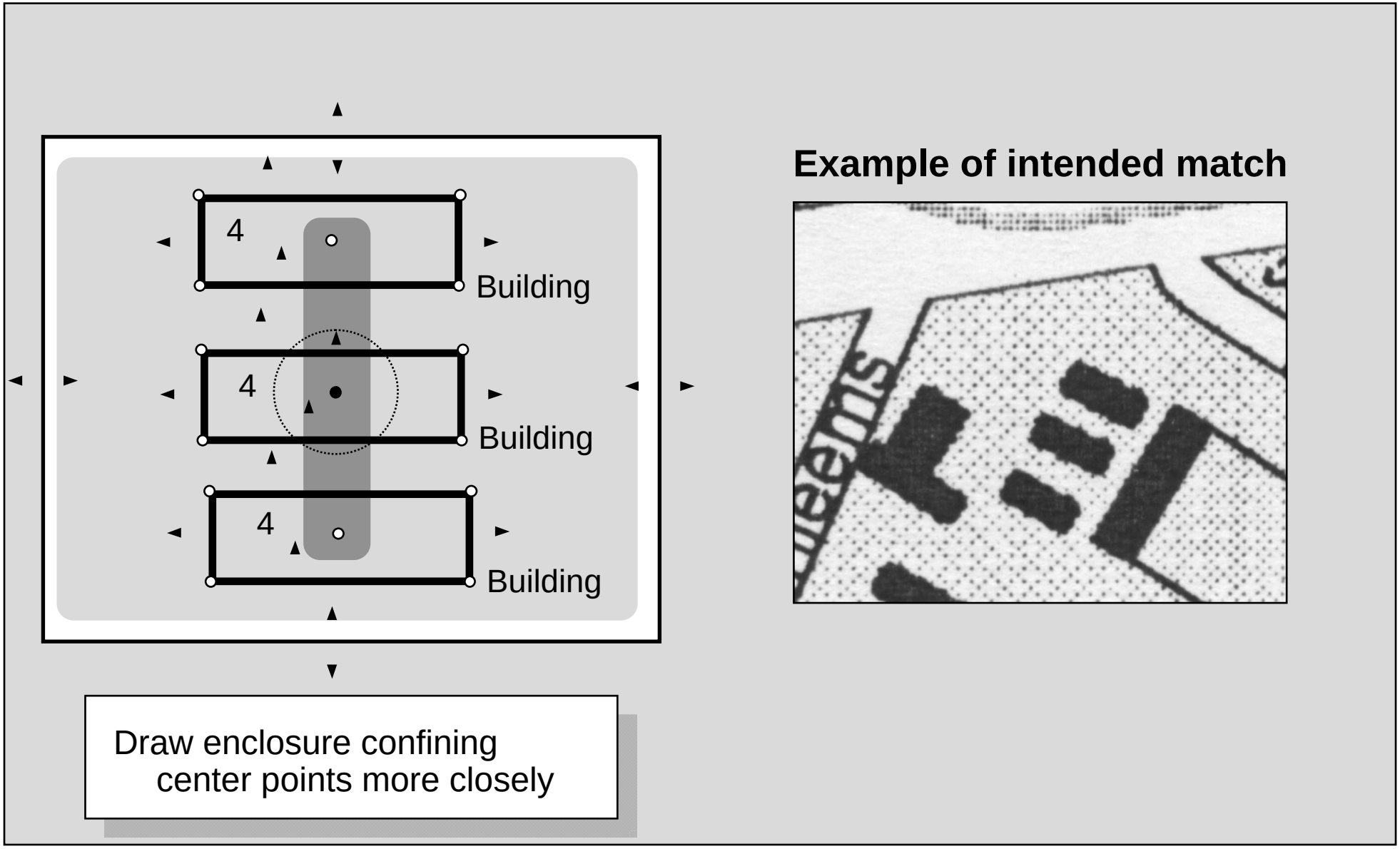
City Map Example: 3 adjacent buildings aligned in parallel (1)



City Map Example: 3 adjacent buildings aligned in parallel (2)



City Map Example: 3 adjacent buildings aligned in parallel (3)



Example of intended match

Conclusion and Ongoing Research

- VISCO is innovative compared to other relevant approaches (see related work in paper)
  - geometric as well as topological queries or combination of both
  - high expressiveness by interpreting topological relations as qualitative constraints enriched with meta information
  - simple but powerful 'naive physics' metaphor
  - approximate or vague objects/constellations possible
- Prototype implementation partially completed (user interface)
- Query semantics specified by translational semantics (typed lambda calculus)
- Description logic framework for query processing and optimization is under development