

# Description Logics for Vision-Based Urban Intersection Understanding

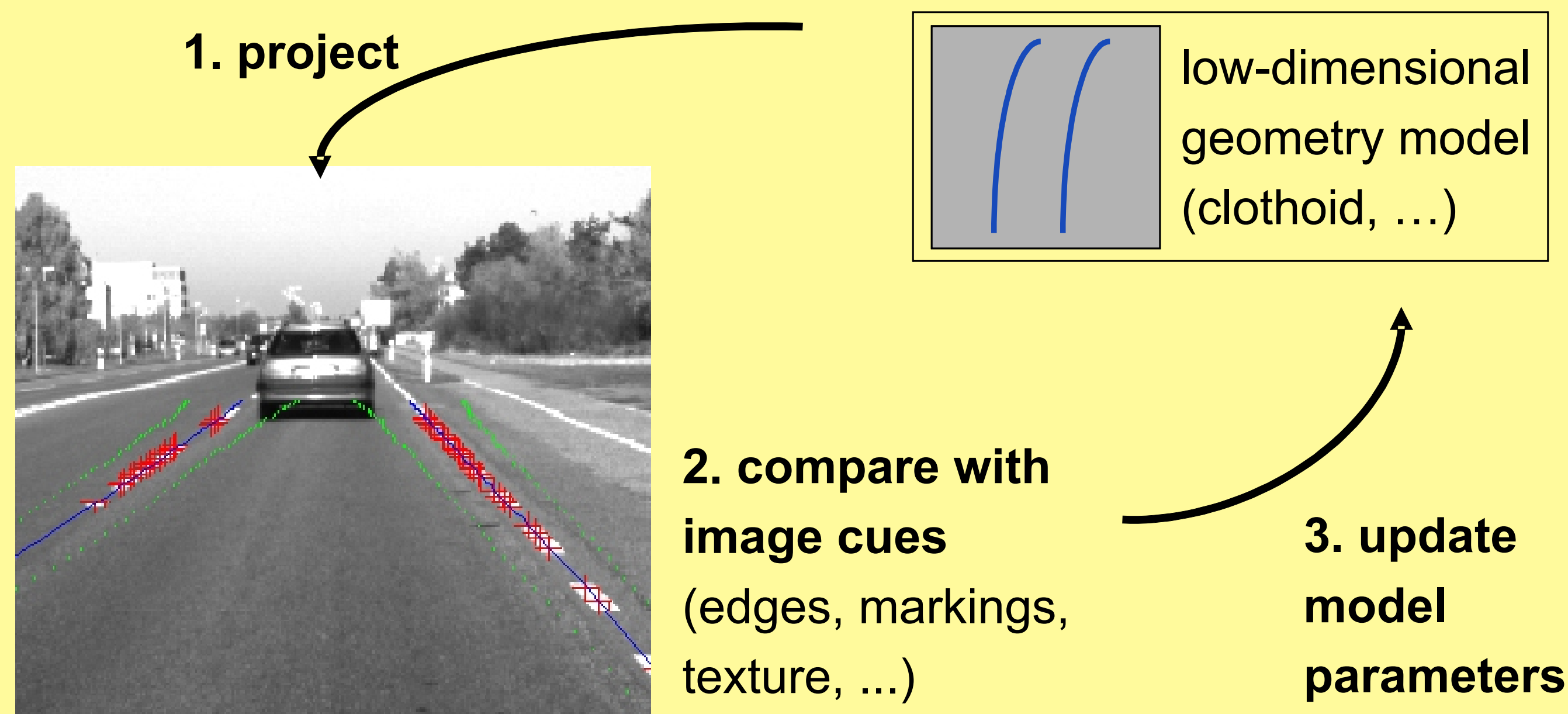
## Definition "Intersection Understanding"

:= Image Understanding for road intersection images, (at least) for

- Autonomous navigation through intersection, obeying traffic rules
- Generation of a human-readable, qualitative scene description

How?

## Common Approach to Lane Recognition

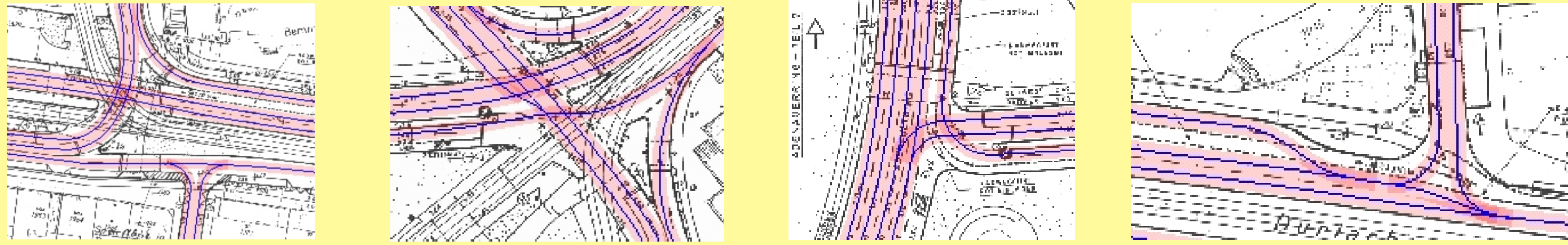


→ Cannot be generalized to more complex environments!

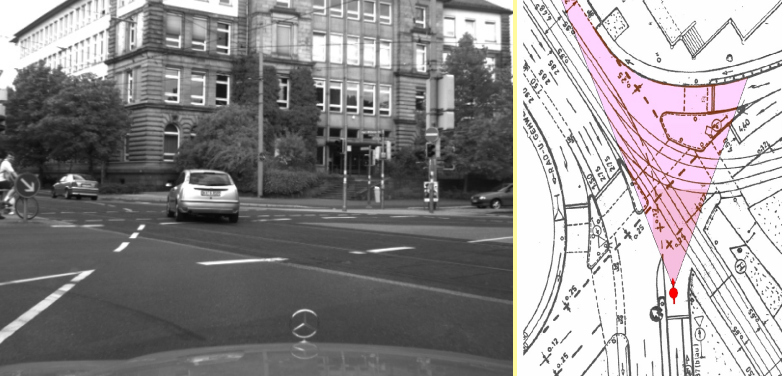
Why?

## Challenges in Intersection Understanding

### 1. High-dimensional hypothesis space



### Limited field of view



### 2. Few measurements Heavy occlusions



### Lacking features



### 3. Noise

Unmodelled objects  
Bad feature quality

→ Problem becomes ill-posed!

What can we do?

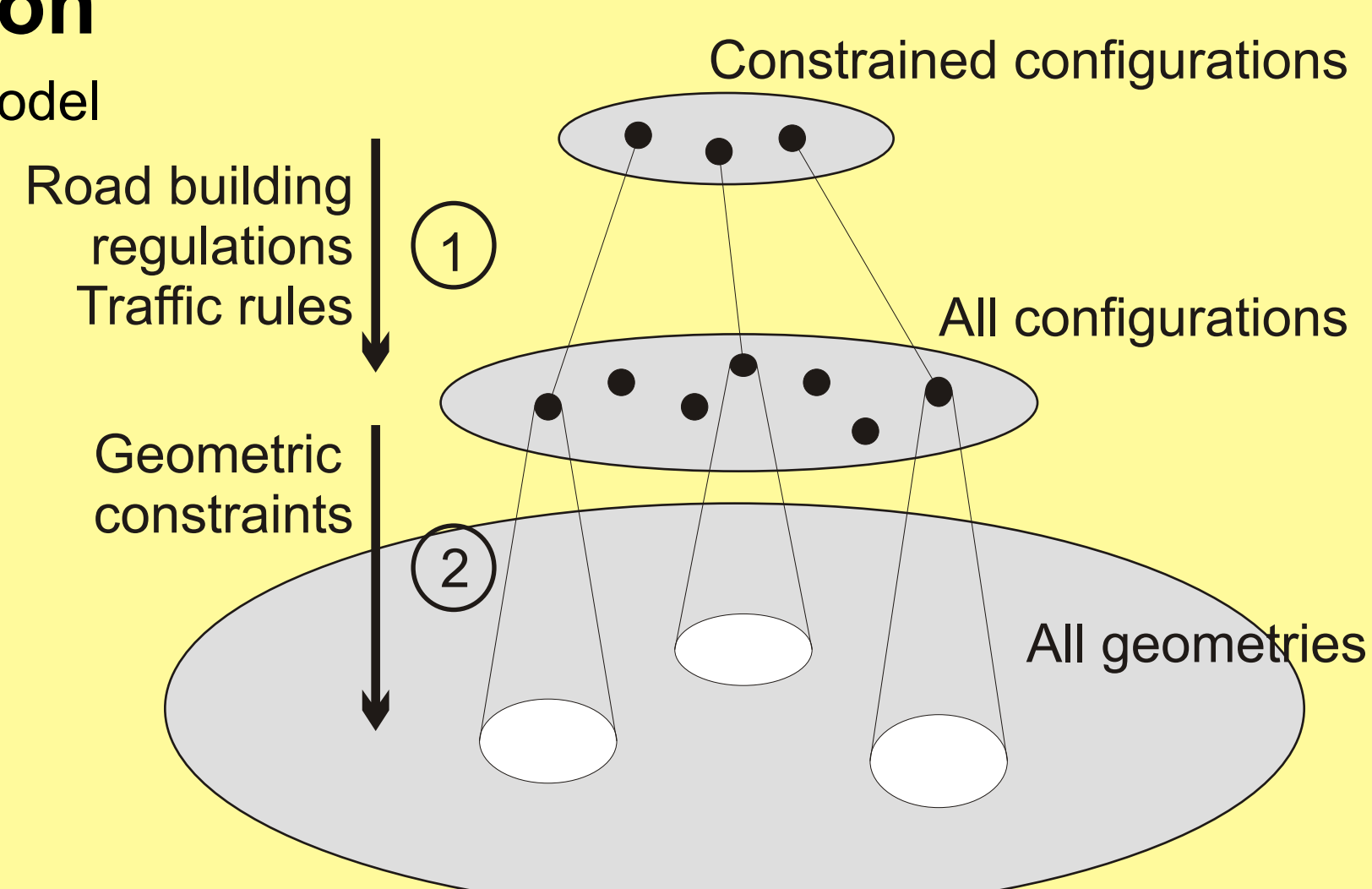
## Prerequisites for Intersection Understanding

- Hardware: active / omnidirectional cameras
- Large nr of complementary feature detectors  
Example Crossroad: crossing vehicle, stop sign, traffic light, pedestrian crossing, arrow marking, lateral marking, exit lane right,...



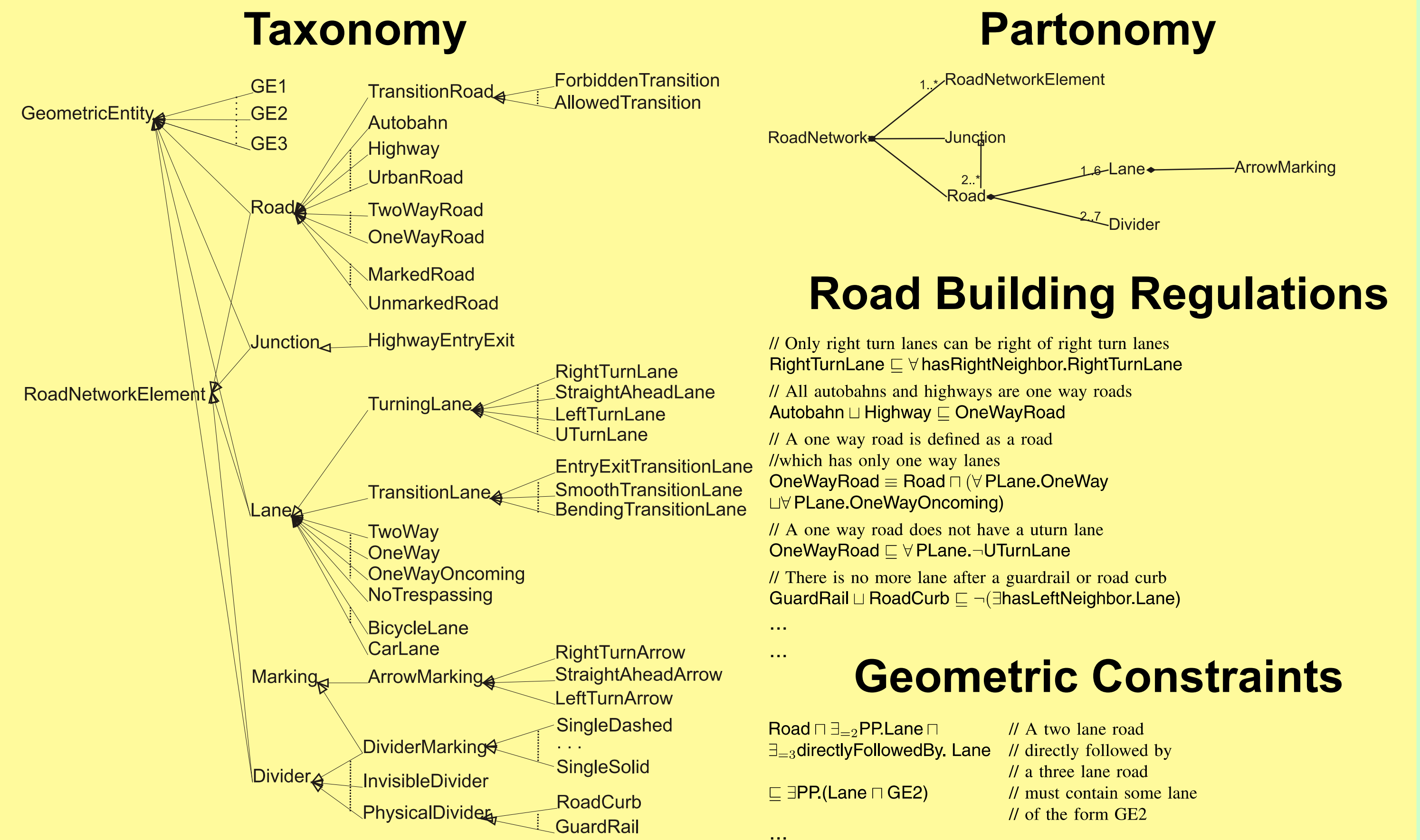
### 3. Knowledge representation

- Develop high-dimensional geometry model
- Narrow down hypothesis space
- Specify domain knowledge on a conceptual level
- Explicate all assumptions
  - Maintainable KR
  - Extendable KR
- Use a highly formalized language
  - Allows for reasoning
  - Avoids semantic ambiguities



## Knowledge Representation for Roads and Intersections

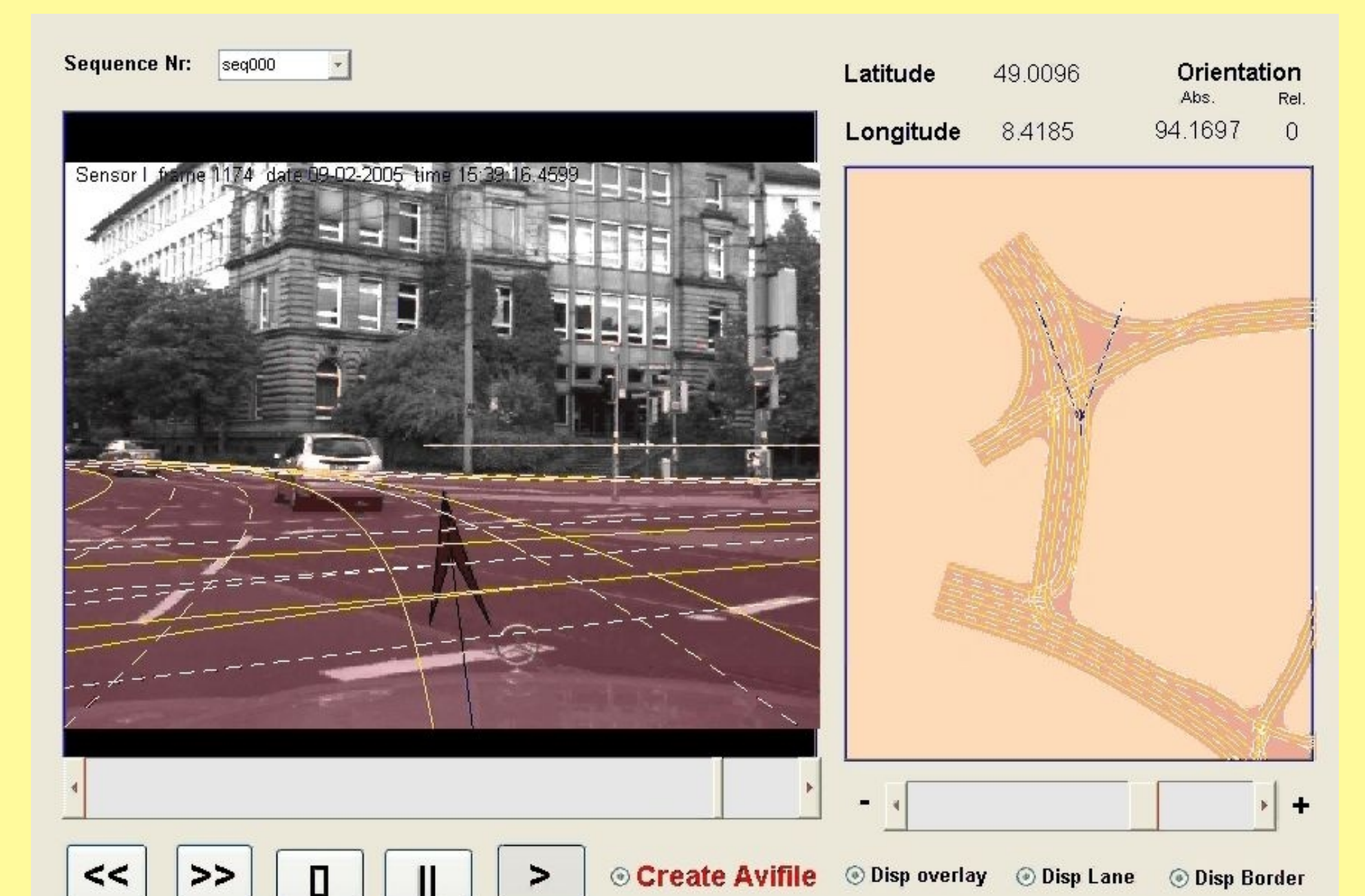
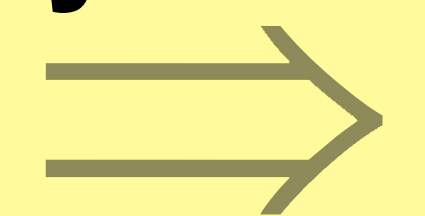
with the Description Logic  $ALCQHI_{R+}(D^-)$



DL Inference

- Satisfiability** Does the knowledge base make sense?
- Consistency** Does the sensor data make sense?
- Entailment** Determines the most specialized individual description that deductively follows from the KB  
 $KB \models \text{lane}_i : (\text{OneWayLane} \sqcap \text{RightTurnLane})$
- Query answering** Retrieves individuals; similar to database query

yields



Model of intersection geometry and configuration

## Problem:

Deductive Inference requires monotonicity!

Therefore, a complete low-level segmentation must be provided. But Computer Vision has shown: Data-driven segmentation not feasible.

Outlook

## (Non-monotonic) Model Construction

