Motivation: Inconsistent Traffic Regulation Scenarios

Use Cases
- Bad traffic sign posting
- Ambiguous or contradictory restrictions such as speed limits
- Complicated or impossible routes (trafficability)
- Traffic signs do not correspond with underlying traffic measures

Relevance
- Legal issues (e.g., challenging speeding tickets)
- Legal responsibility in case of accidents
- Wrong assumptions in urban traffic planning
- Real-time coordination in Active Traffic Management

Goals and Challenges
- Capturing the meaning of signs and measures
- Complex domain, common sense, exceptions to traffic rules
- Detect errors based on flexible conflict specification
- Find reasonable diagnoses (explanations) and repairs
- Non-standard reachability problems

Real World Scenario I

Missing repeating start sign at y₁

Repair

Real World Scenario II

Loop caused by four mandatory left-turns
Note: Removing the traffic sign at d₁ is not a repair

Decision problems
- CONS: Are measures and signs consistent?
- CORR: Do they express the same restrictions? (Correspondence)
- UMINDIAG: Decide, whether a unique, C-minimal diagnosis exists
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Search and optimization problems
- DIAGNOSIS: Find min. parts of the input explaining inconsistency
- REPAIRS: Find reasonable corrections for conflicts
- STRICT REPAIRS, ADJUSTMENT, GENERATION: Special repairs

Complexity Results
- Complexity results for decision problems in different logics
- First-order logic under domain closure
- Answer Set Programs: stratified, normal, and disjunctive programs; complexity increases in this order
- Analyzed general case and with bounded predicate arities (BPA)
- Generally high complexities, e.g., PNP up to PSpace for CONS (BPA)

Logic-based Approach
- Modelling street map as directed, labelled graph
- Explicit distinction between traffic measures and traffic signs
- Specify conflicts by formulas in some predicate logic
- Inconsistency if a conflict can be derived
- Focusing on Answer Set Programming as logic
- Basis for modular and understandable implementation

Prototype Implementation
- Answer Set Programming prototype using DLV and Potassco
- Uniform encoding for all reasoning tasks
- Declarative traffic regulation as modular sets of rules
- Input: Facts encoding the street graph, and traffic measures & signs
- Output: Answer sets reflecting conflicts/diagnoses/repairs
- Reasoning tasks are solved by small additions to a core program