

Towards a traffic understanding by ontology-based rules

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HiTeC

Hamburger Informatik
Technologie – Center e.V.

WHO IS



Hamburger Informatik Technologie-Center e.V.

We are **the institution for technology transfer** between the
Department of Informatics at Hamburg University
and Companies and Research Institutions.

Managing Director

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Board

Prof. Dr. Chris Biemann

Prof. Dr. Tilo Böhmann

Prof. Dr. Winfried Lamersdorf

Prof. Dr. Walid Maalej

Legal form

Registered non-profit association

Members

Scientists of the Department of Informatics,
companies as sponsoring members

OUR FOCUS

Our projects always have the focus on
research & development

- Contract research and development
- Funded cooperation projects (BMBF, BMWI, BMVI, EU, ZIM, IFB etc.)
- Consulting and studies
- Seminars
- Project support

Important aspect:

We realize **cooperation** projects with relevant **research** content

DO YOU UNDERSTAND WHAT IS GOING ON HERE?



Source: Pixabay

DO YOU UNDERSTAND WHAT IS GOING ON HERE?

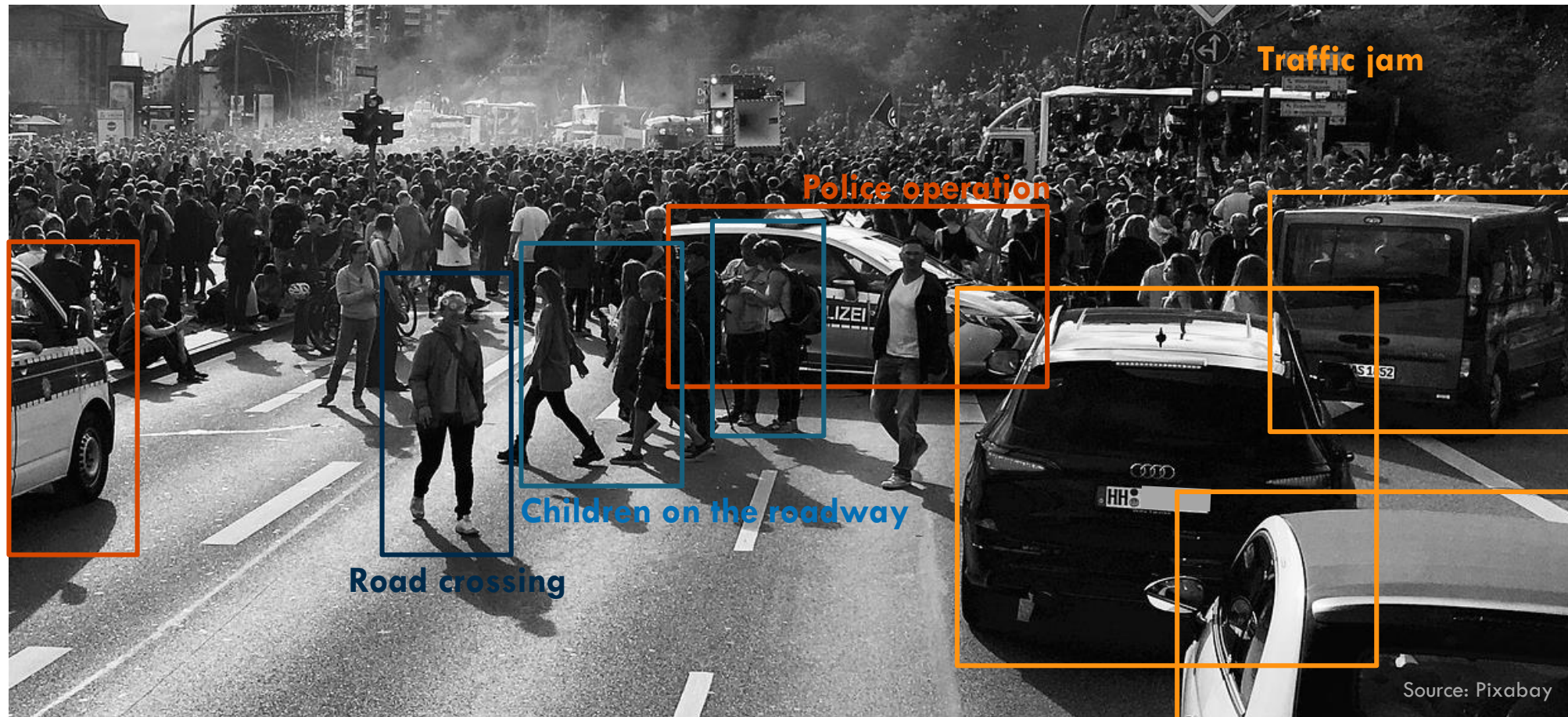
Humans can understand situations in fractions of a second.



Source: Pixabay

DO YOU UNDERSTAND WHAT IS GOING ON HERE?

Machines cannot with ease.



WHAT IS SCENE UNDERSTANDING?

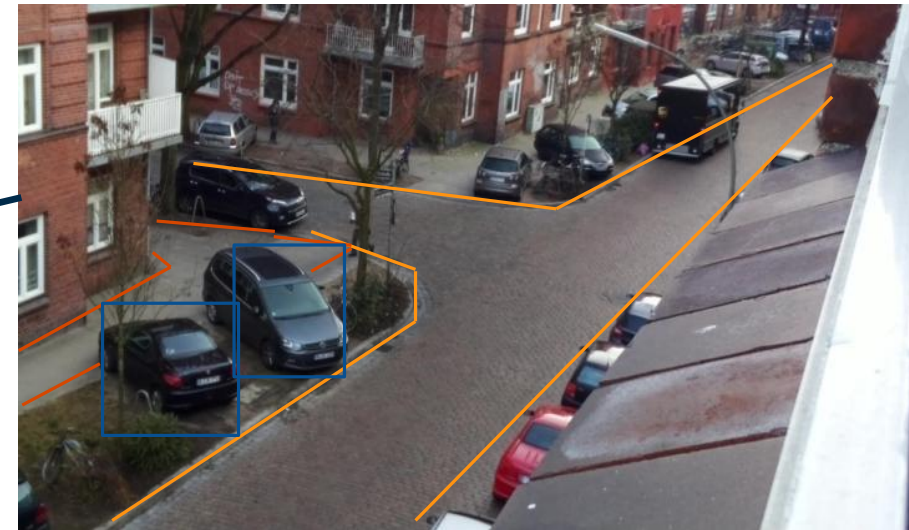
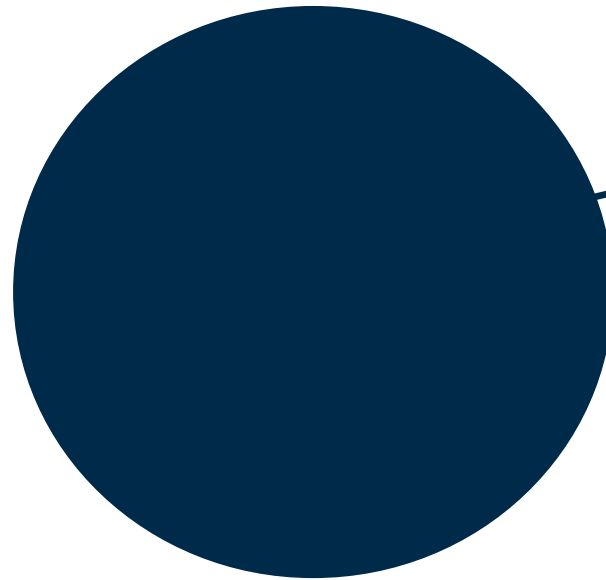
Scene

temporal sequence of actions and states of one or more actors (road users like pedestrians, cars)

Understanding

a system can create a comprehensive, contextualized, formal description of what is happening and the description can be used to answer questions

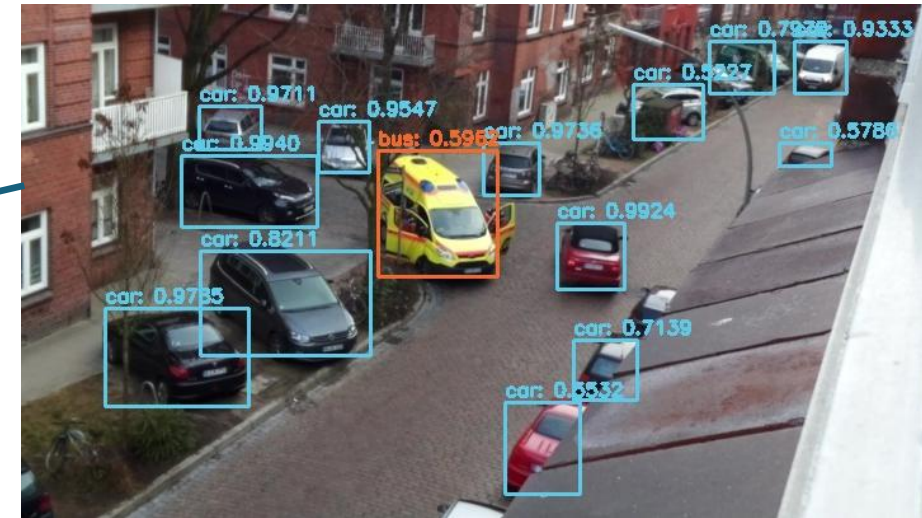
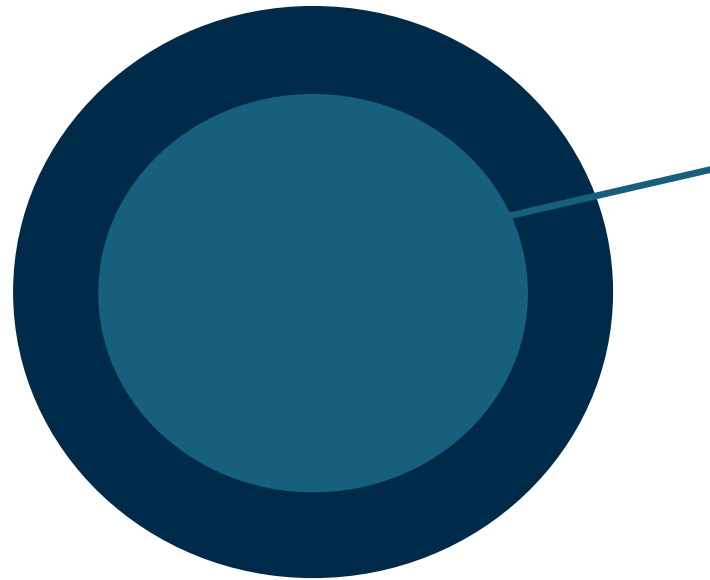
TOWARDS SCENE UNDERSTANDING



Object classification:

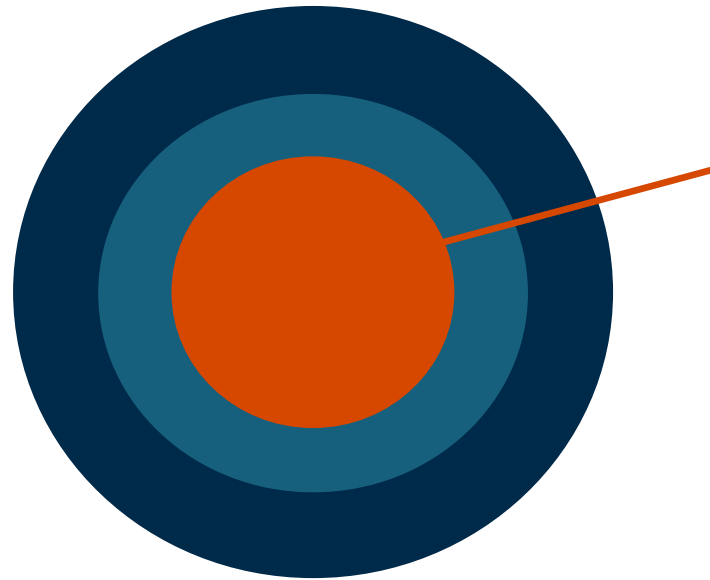
each segment of a frame or image will be labeled with a certain type, foreground objects or background regions, e.g. cyclist, foot path, road

TOWARDS SCENE UNDERSTANDING



Object identification & tracking:
enables the identification and naming of certain objects
and tracking in time and space, e.g. cyclist2, footpath1

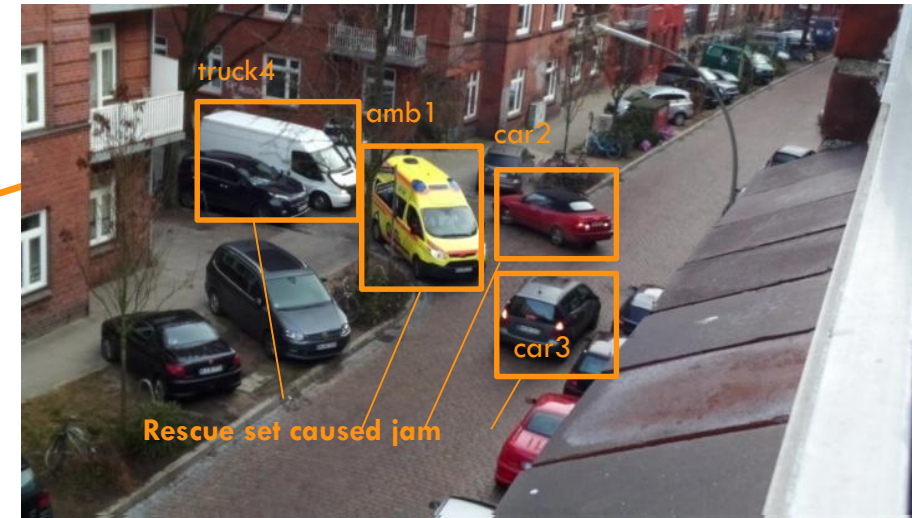
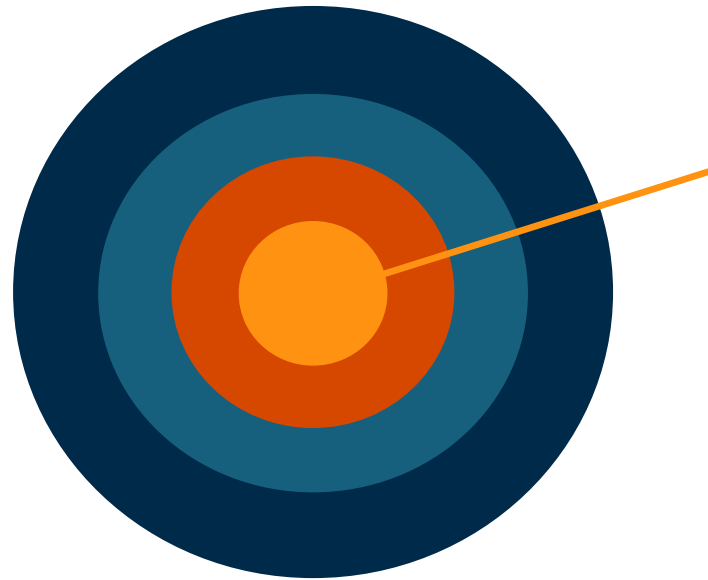
TOWARDS SCENE UNDERSTANDING



Primitive Events:

represents the movement of an object through type, identification, start and endtime and trajectory e.g. `drive(car2, road3, starttime, endtime, path)`

TOWARDS SCENE UNDERSTANDING

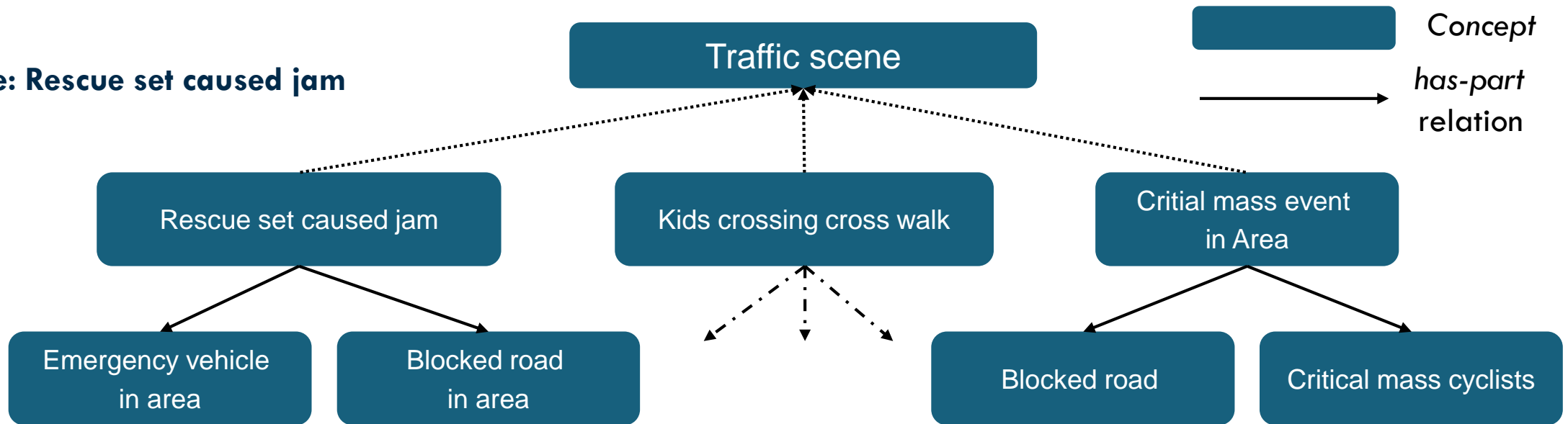


Scene composition:

is an aggregation of primitive events that fulfill certain constraints related to time, space and context like weather e.g. `rescue_set_jam(rescue_set, blockage)`

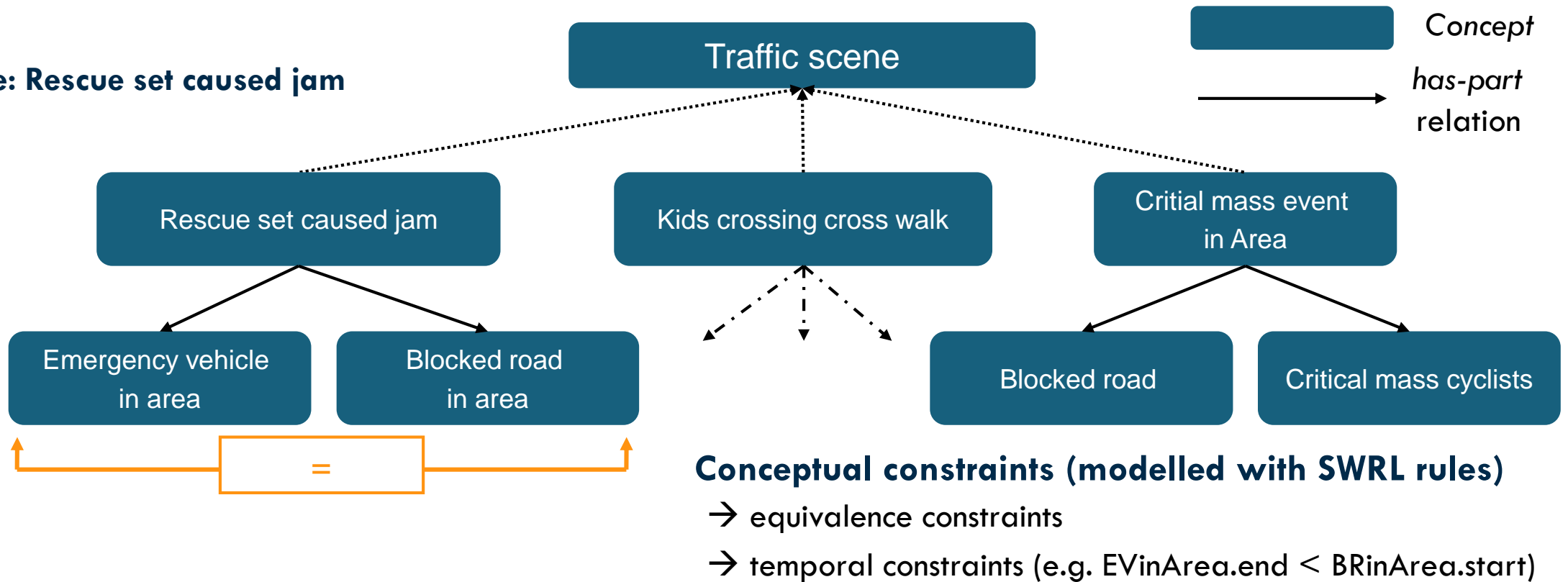
MODELING SCENES WITH ONTOLOGIES

Example: Rescue set caused jam



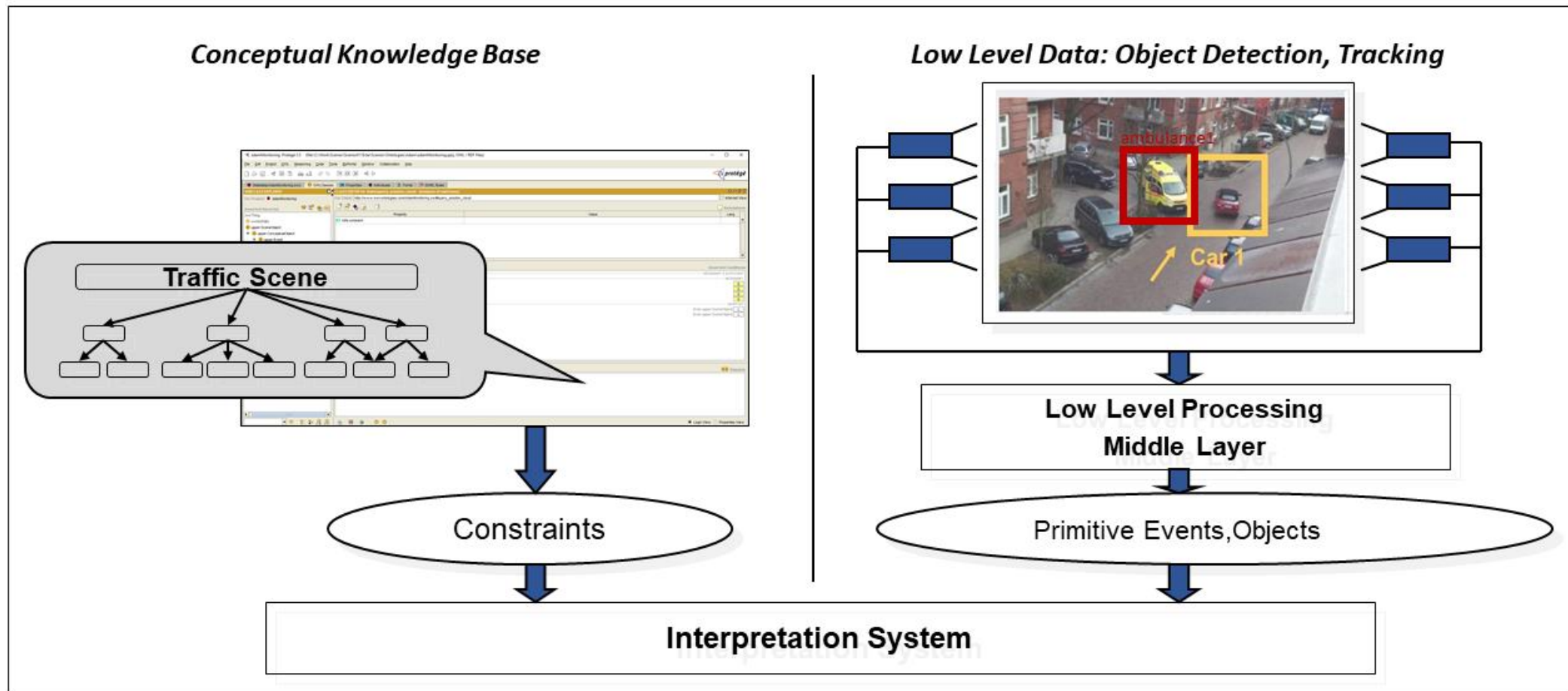
MODELING SCENES WITH ONTOLOGIES

Example: Rescue set caused jam



Concept + conceptual constraints => **aggregate**

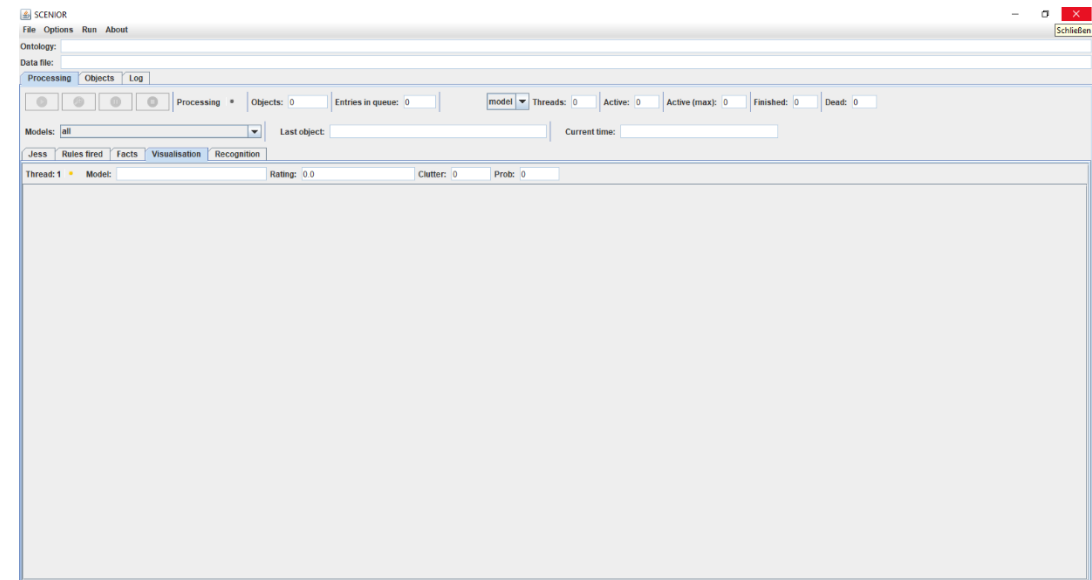
SCENE INTERPRETATION BY ONTOLOGY-BASED RULES



TOOL

SCENIOR – SCENE INTERPRETATION BY ONTOLOGY-BASED RULES

- Scenes and events are described in compositional models in a knowledge base.
- Models are provided with constraints.
- **Scenior** translates the knowledge base with the constraints into a **rule system that evaluates the real time data** based on the modeled events.



TOOL SCENIOR IN ACTION

The screenshot displays the Protégé 3.5 interface with the following components:

- Metadata Explorer (Left):** Shows the ontology hierarchy for ITS_Traffic. The selected class is `Odaki:Blockade_CausedBy_Ambulance`.
- Class Editor (Center):** Displays the class definition for `Odaki:Blockade_CausedBy_Ambulance`. It includes a table for properties and values, and a list of instances.
- SWRL Rule Editor (Right):** Shows a SWRL rule named `Odaki:Blockade_CausedBy_Ambulance-Rule`. The rule is a complex logical expression involving various entities and their properties.

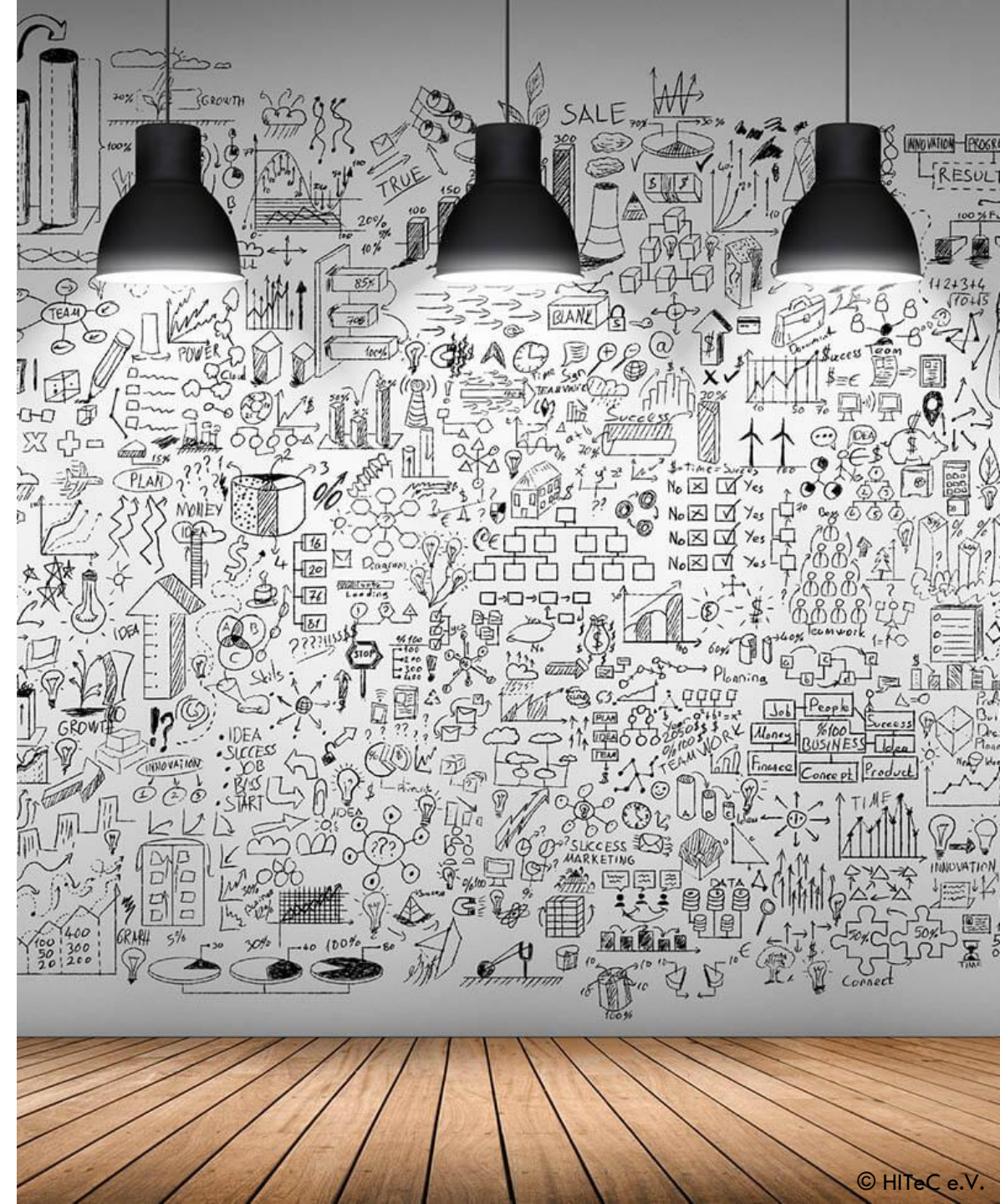
SWRL Rule:

```
Odaki:Blockade_CausedBy_Ambulance(?block) ^ upper:hasPartA(?block, ?esa) ^ Odaki:hasAmbulance(?esa, ?amb1) ^  
Odaki:hasLane(?esa, ?lane1) ^ Odaki:hasBlocking(?block, ?bl1) ^ upper:hasPartB(?bl1, ?drive) ^  
Odaki:hasRoadUser(?drive, ?car1) ^ Odaki:hasLane(?drive, ?lane2) ^ upper:hasPartC(?bl1, ?stand) ^  
Odaki:hasLane(?stand, ?lane3) ^ Odaki:hasRoadUser(?stand, ?car2) ^ upper:hasPartD(?block, ?drive2) ^  
Odaki:hasLane(?drive2, ?lane4) ^ Odaki:hasRoadUser(?drive2, ?car3) ^ upper:hasPartE(?block, ?stand2) ^  
Odaki:hasLane(?stand2, ?lane5) ^ Odaki:hasRoadUser(?stand2, ?car4) ^ constraints:has-start-time(?block, ?block-start) ^  
constraints:has-finish-time(?block, ?block-finish) ^ constraints:has-start-time(?bl1, ?bl1-start) ^  
constraints:has-finish-time(?bl1, ?bl1-finish) ^ constraints:has-start-time(?esa, ?esa-start) ^  
constraints:has-finish-time(?esa, ?esa-finish) ^ constraints:has-start-time(?drive, ?drive-start) ^  
constraints:has-finish-time(?drive, ?drive-finish) ^ constraints:has-start-time(?stand, ?stand-start) ^  
constraints:has-finish-time(?stand, ?stand-finish) ^ constraints:has-start-time(?drive2, ?drive2-start) ^  
constraints:has-finish-time(?drive2, ?drive2-finish) ^ constraints:has-start-time(?stand2, ?stand2-start) ^  
constraints:has-finish-time(?stand2, ?stand2-finish) ^  
swrib:equal(?car1, ?car2) ^ swrib:equal(?car3, ?car4) ^ swrib:equal(?lane1, ?lane2) ^ swrib:equal(?lane1, ?lane3) ^  
swrib:equal(?lane1, ?lane4) ^ swrib:equal(?lane1, ?lane5) ^ constraints:min-before(?block-start, ?esa-start, 0) ^  
constraints:min-before(?esa-start, ?block-start, 0) ^ constraints:min-before(?esa-start, ?stand-start, 0) ^  
constraints:min-before(?esa-start, ?drive-start, 0) ^ constraints:min-before(?bl1-start, ?drive-start, 0) ^  
constraints:min-before(?drive-start, ?bl1-start, 0) ^ constraints:min-before(?bl1-finish, ?stand-finish, 0) ^  
constraints:min-before(?stand-finish, ?bl1-finish, 0) ^ constraints:min-before(?drive-finish, ?stand-start, 0) ^  
constraints:min-before(?stand-finish, ?drive2-start, 0) ^ constraints:min-before(?drive2-finish, ?stand2-start, 0) ^  
constraints:min-before(?block-finish, ?esa-finish, 0) ^ constraints:min-before(?esa-finish, ?block-finish, 0)
```



OUR EXPERIENCE IN SCENE INTERPRETATION

- Monitoring tasks (e.g. adapting autonomous machines or airport activity recognition)
- Criminal acts recognition (e.g. cyber security)
- Learned activity models for scene interpretation, planning, and prediction in robotics
- Traffic scene interpretation



SCENE INTERPRETATION OF ROAD TRAFFIC

SmartWalk

Protection of vulnerable road users with intelligent traffic infrastructure:

- smart crosswalk
- privacy-compliant camera system
- Scenior

Funded by the German Federal Ministry of Traffic
an intelligent Infrastructure (BMVI) by mFund



[Source: AS Bercman Technologies]

THANK YOU FOR YOUR ATTENTION!

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