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HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

Simulating Traffic Networks

Driving SUMO towards digital twins

Axel Schaffland, Jonas Nelson, and Julius Schöning

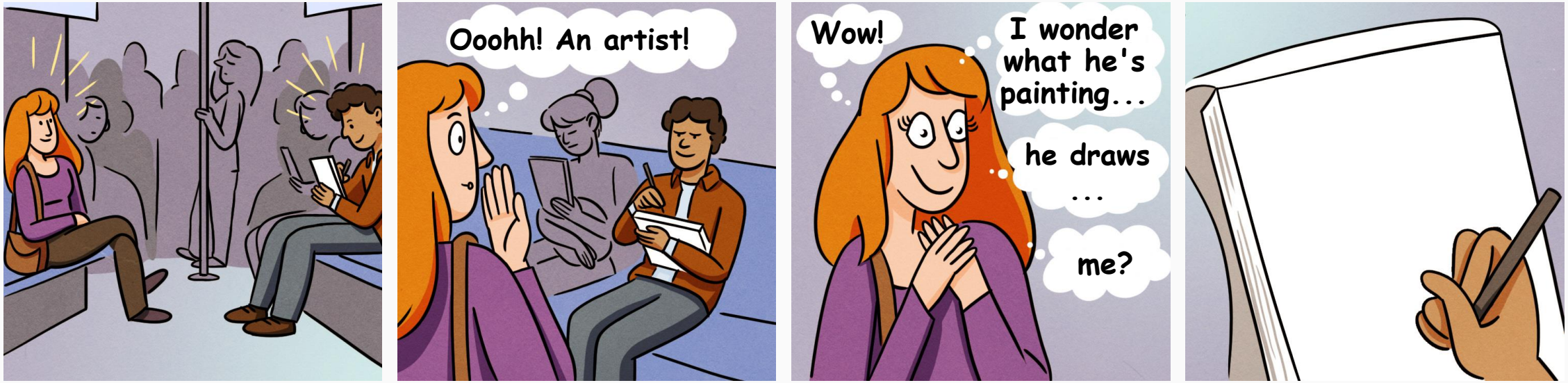
14/05/2024

Hochschule Osnabrück – Fakultät Ingenieurwiss. und Informatik

Completely without personal reference

The modern way of drawing

The modern way of drawing - Prompt Engineers: The new artists?



Idea from: https://www.linkedin.com/posts/manuel-villavieja-beck-1714a023a_are-so-called-prompt-engineers-the-new-activity-7049459145556598784-wSCC (10/04/2024)

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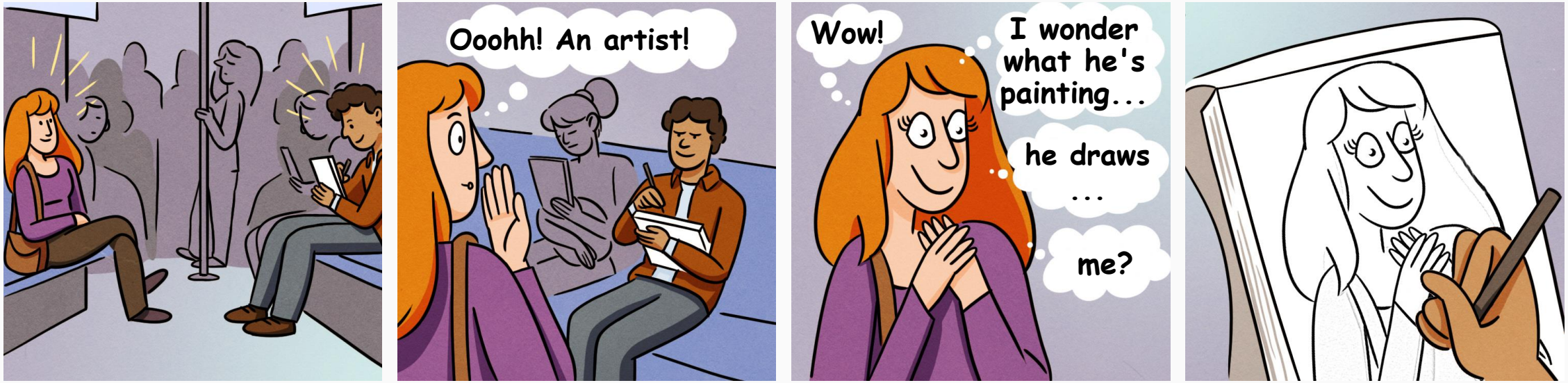

two years ago

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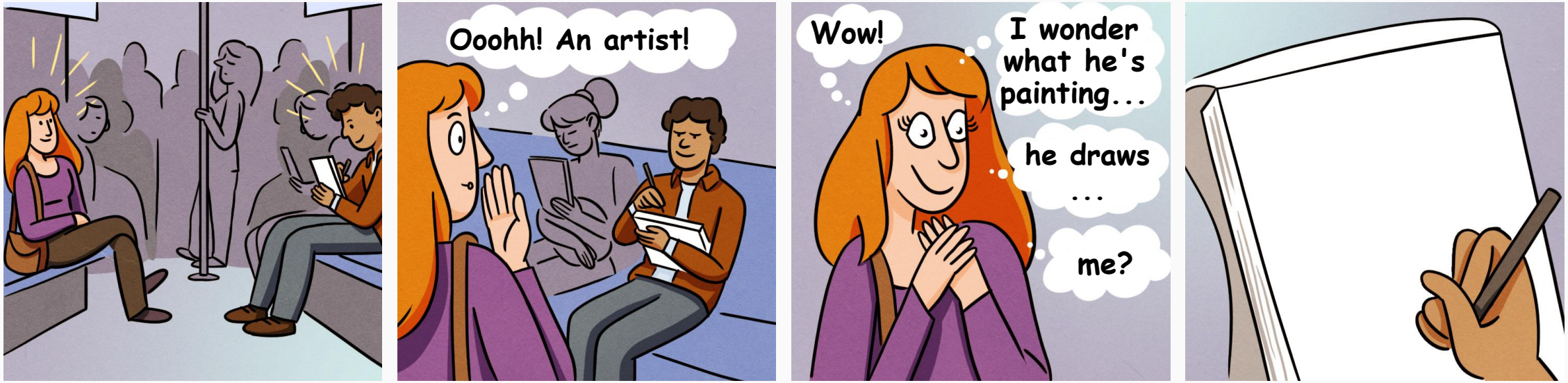

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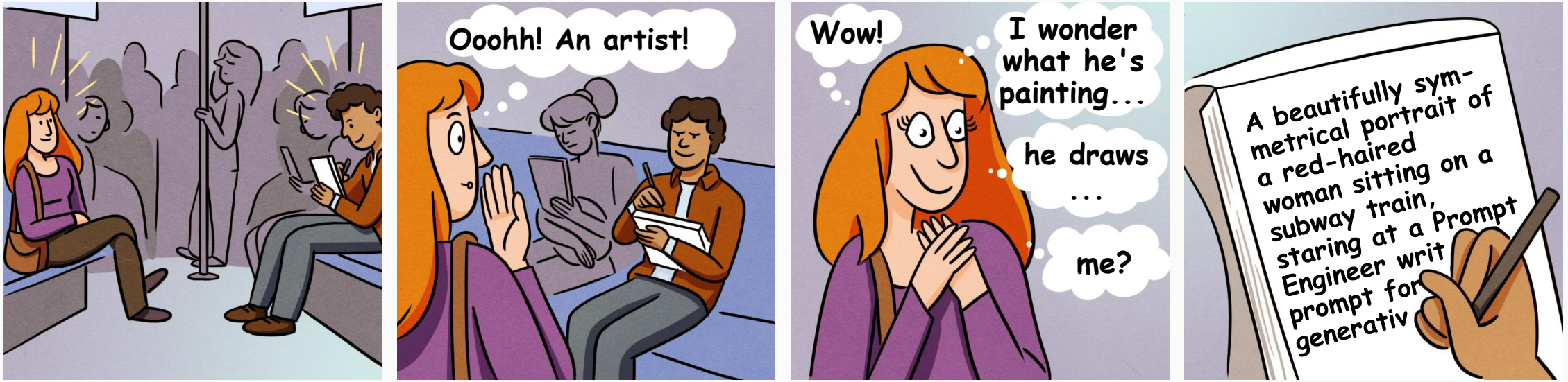

today

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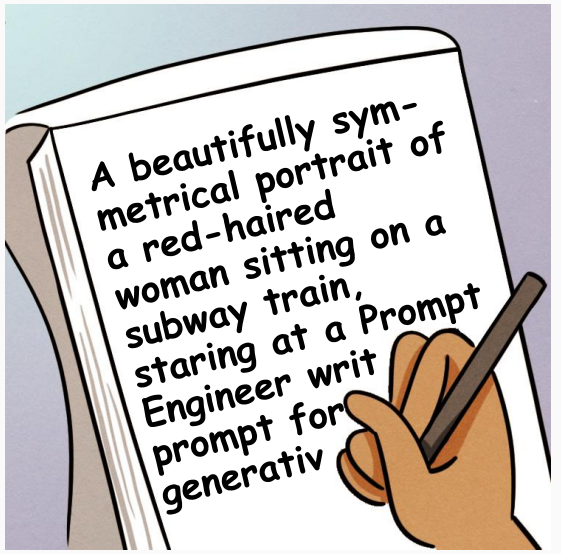

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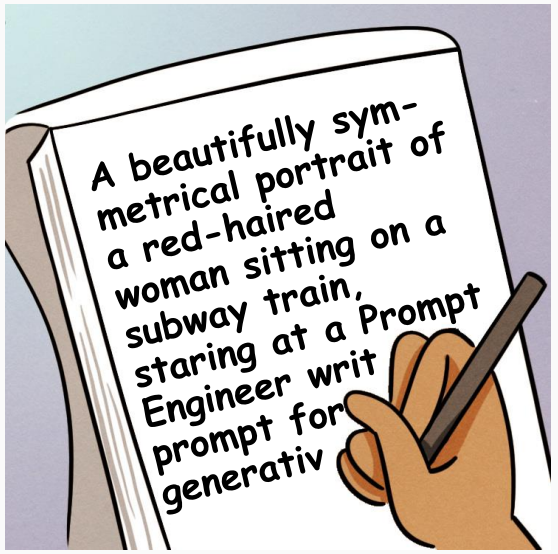

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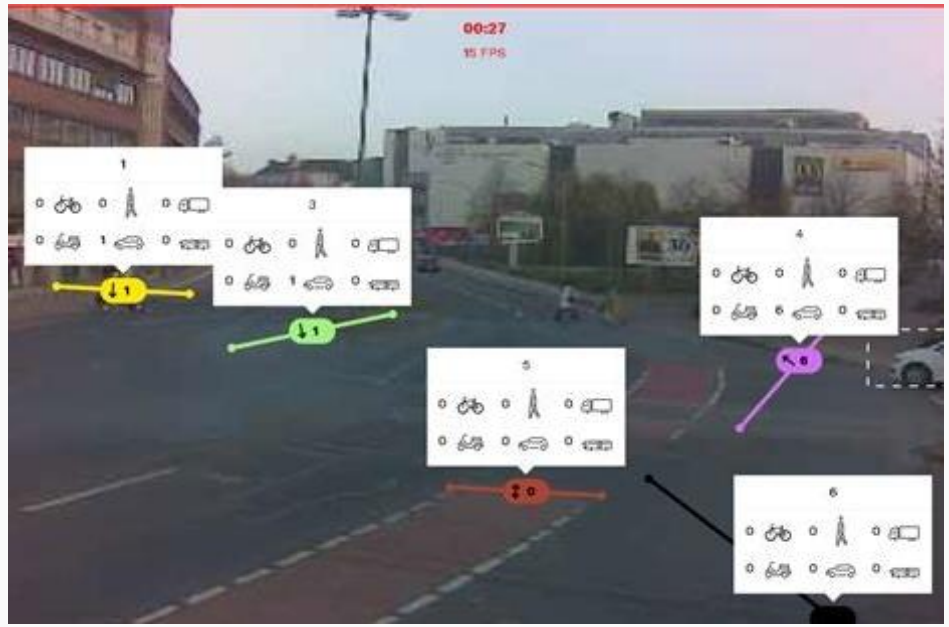
Intelligent Intermodal Commuter Traffic

The research project and its aim

Intelligent Intermodal Commuter Traffic

Motivation: Increase in individual and commuter traffic in
- Osnabrück (pop. 165,000 / 128,700 commuters)
- Münster (pop. 317,700 / 219,400 commuters)



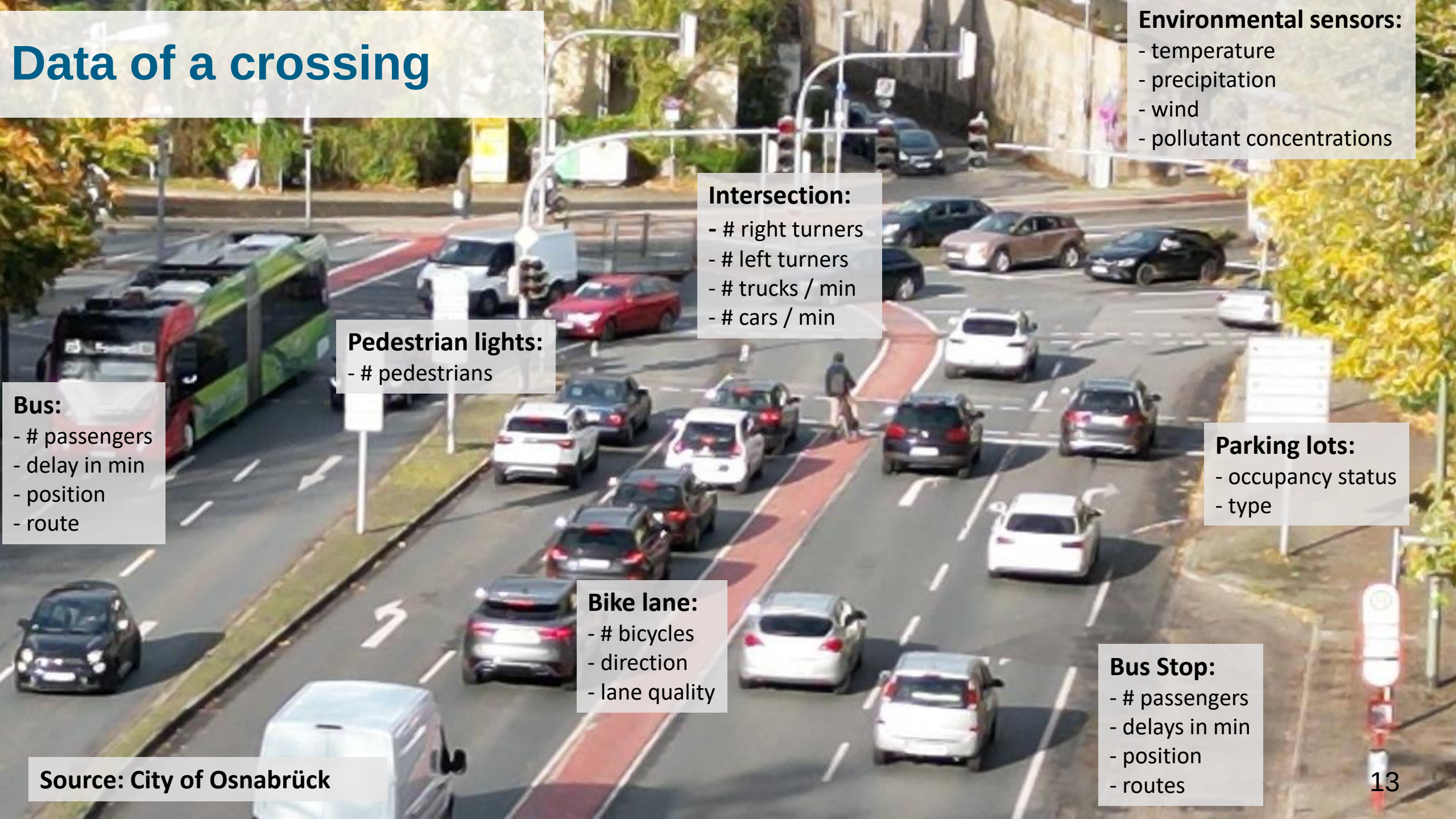
Solution approach:

- Merging official and publicly available traffic data with sensor technology, crowdsourcing and citizen participation
- Protection of privacy through anonymized data collection
- Development and testing of business models oriented towards the common good with a focus on the intelligent use of different means of transport
- Cooperation partners: SWO Netz GmbH, Stadt Osnabrück, Hochschule Osnabrück, Universität Münster, items GmbH & Co. KG, iotec GmbH, Lambus GmbH, cybob communication GmbH

Simulating Traffic Networks

Data of a crossing

Data of a crossing



Environmental sensors:
- temperature
- precipitation
- wind
- pollutant concentrations

Intersection:
- # right turners
- # left turners
- # trucks / min
- # cars / min

Pedestrian lights:
- # pedestrians

Bus:
- # passengers
- delay in min
- position
- route

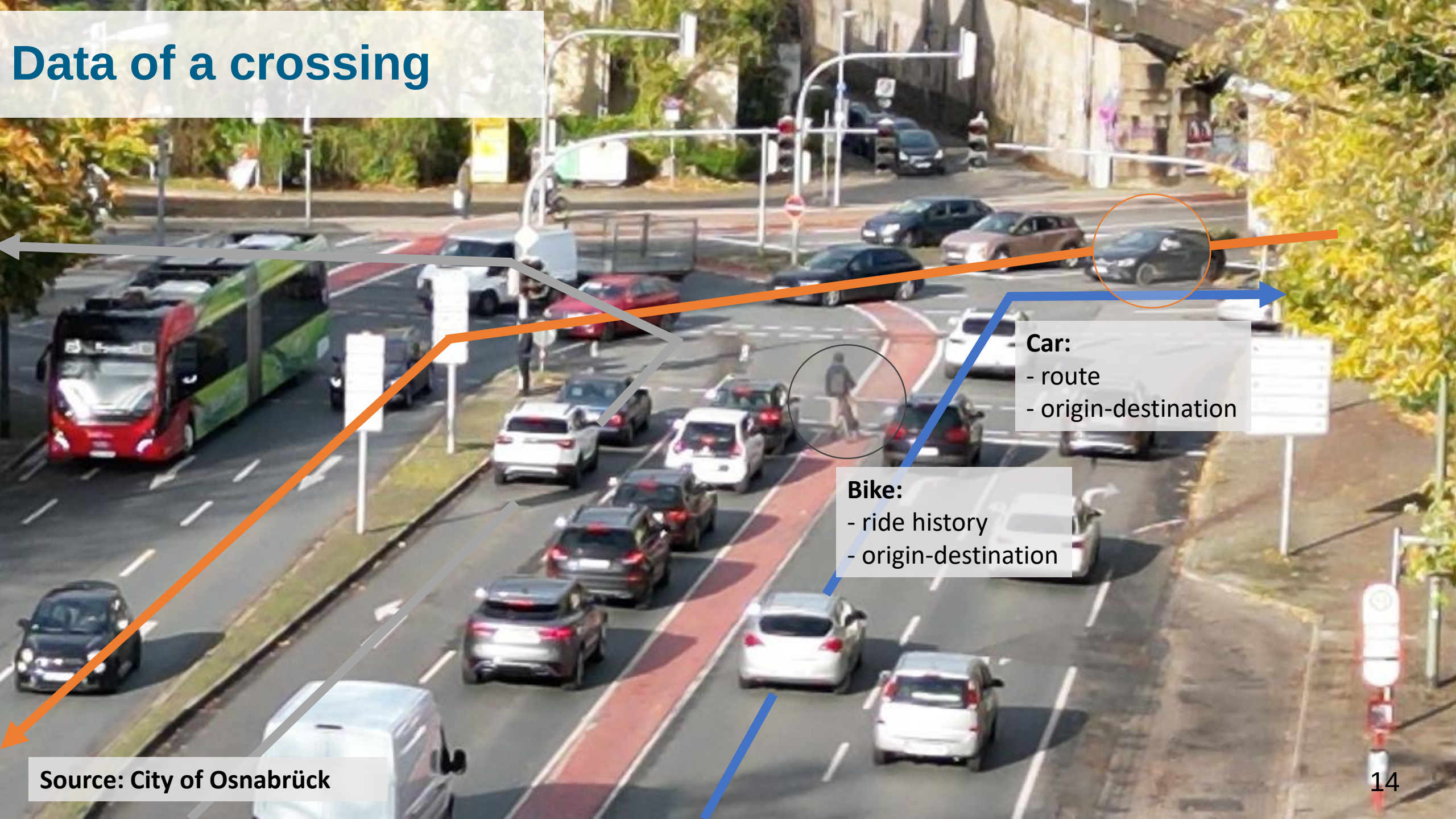
Parking lots:
- occupancy status
- type

Bike lane:
- # bicycles
- direction
- lane quality

Bus Stop:
- # passengers
- delays in min
- position
- routes

Source: City of Osnabrück

Data of a crossing



Source: City of Osnabrück

Data of a crossing

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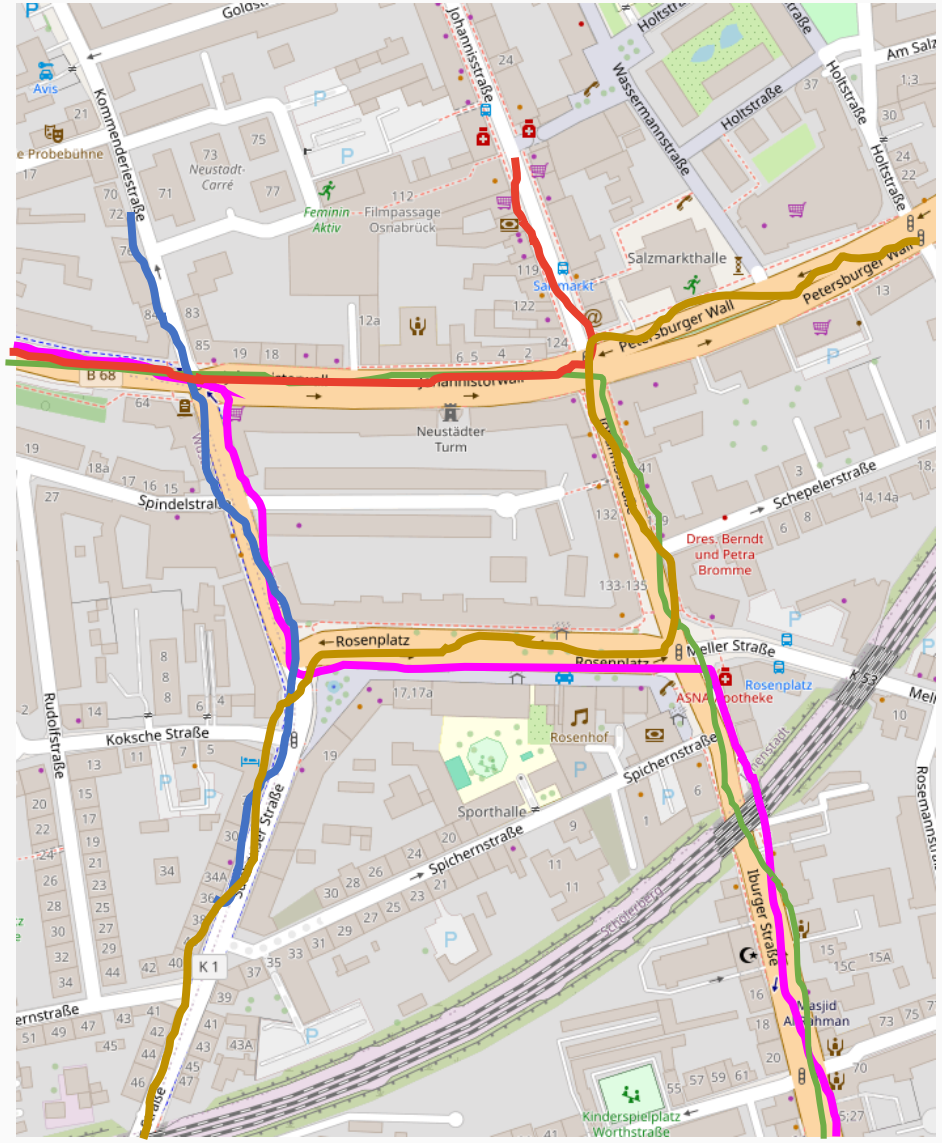
Data of a crossing

Source: City of Osnabrück

Simulating Traffic Networks

Sensor-based traffic simulation

Motivation: Sensor-based traffic simulation



- improving public transportation
- reduction of environmental pollution
- human-centered urban planning
- traffic flow optimization
- improving the quality of life
- accident prevention
- real-time traffic management
- ...

pedestrian

cyclist

bus R42

truck (40 tons)

car (3 passengers)

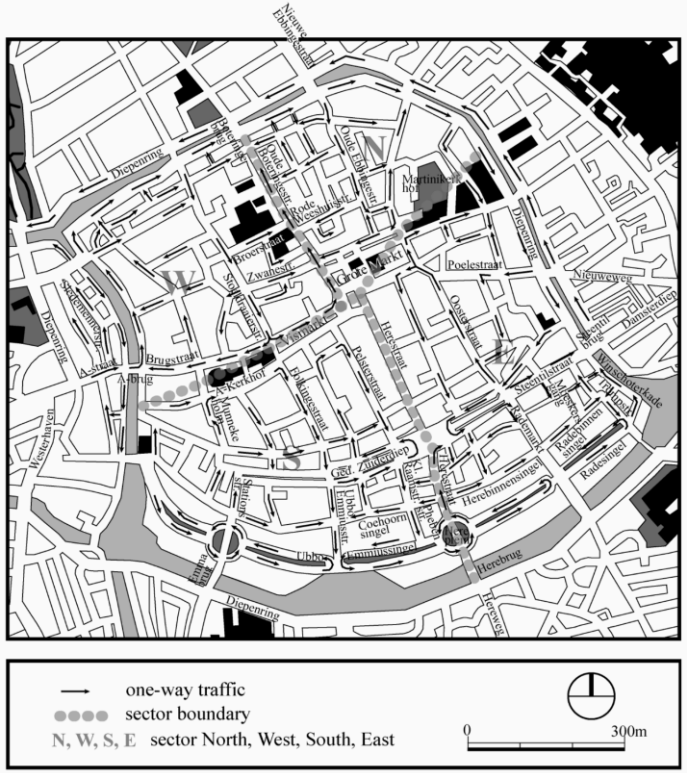
…

intelligent pendeln

Motivation: Sensor-based traffic simulation

Supermanzana Barcelona

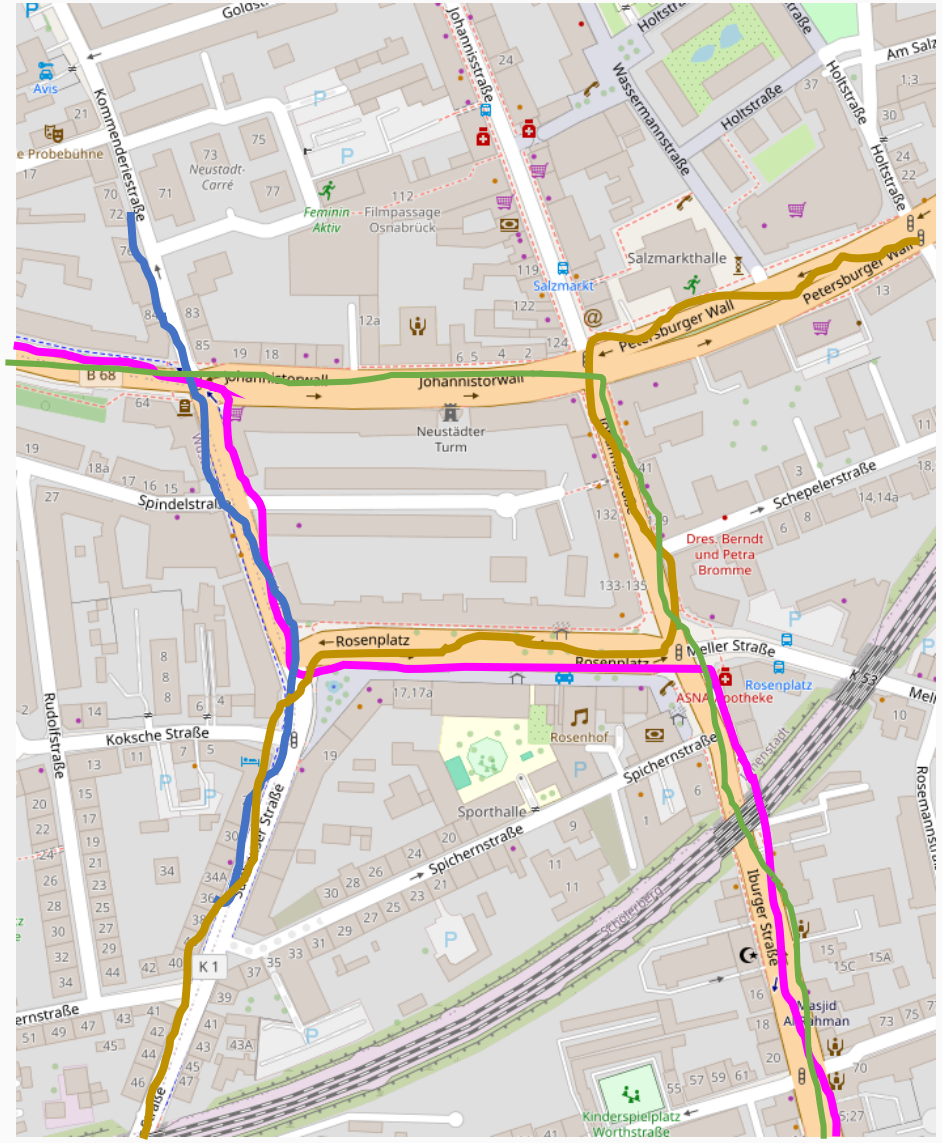
Leezenflow Münster

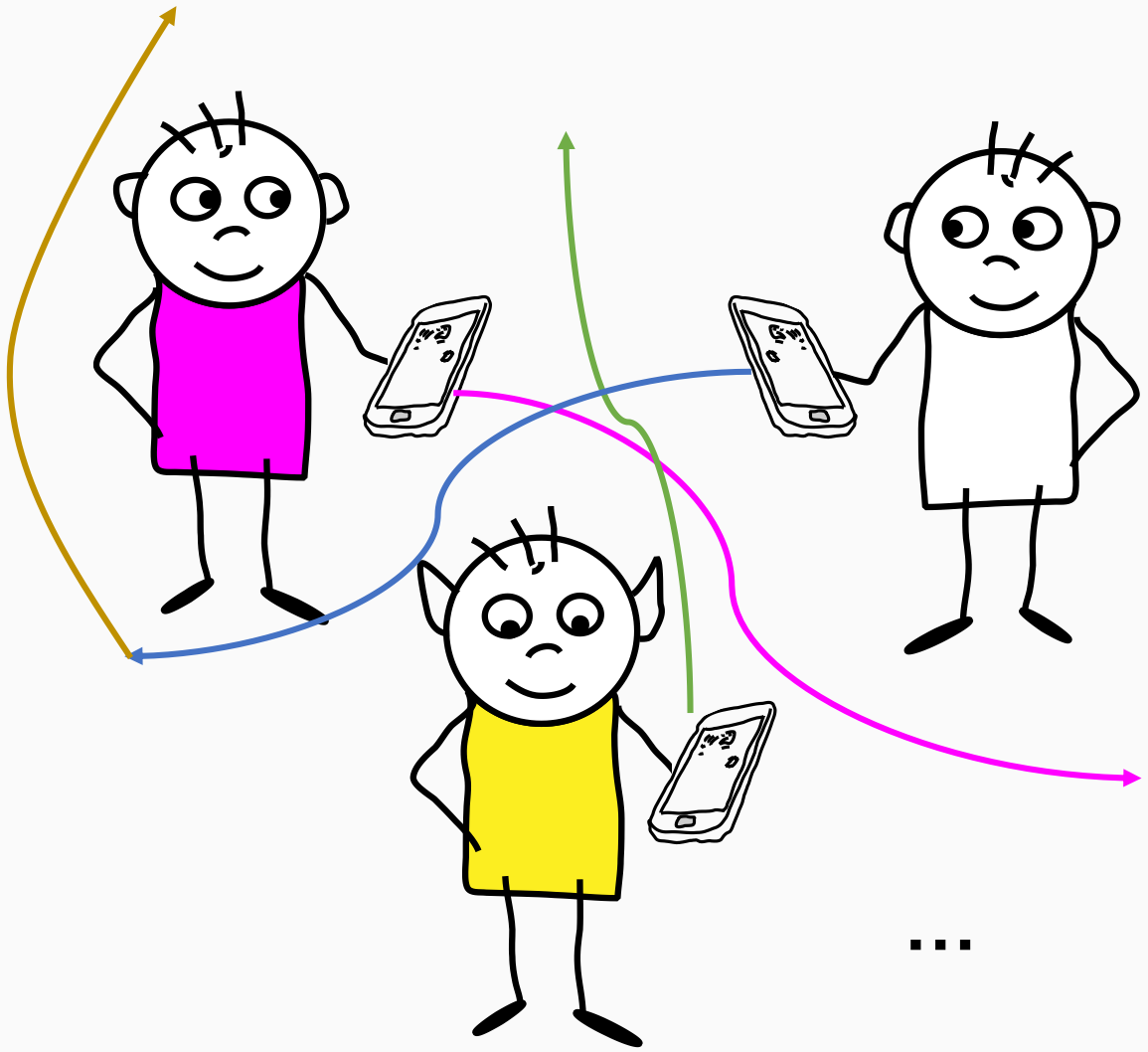


Traffic Circulation Plan Groningen

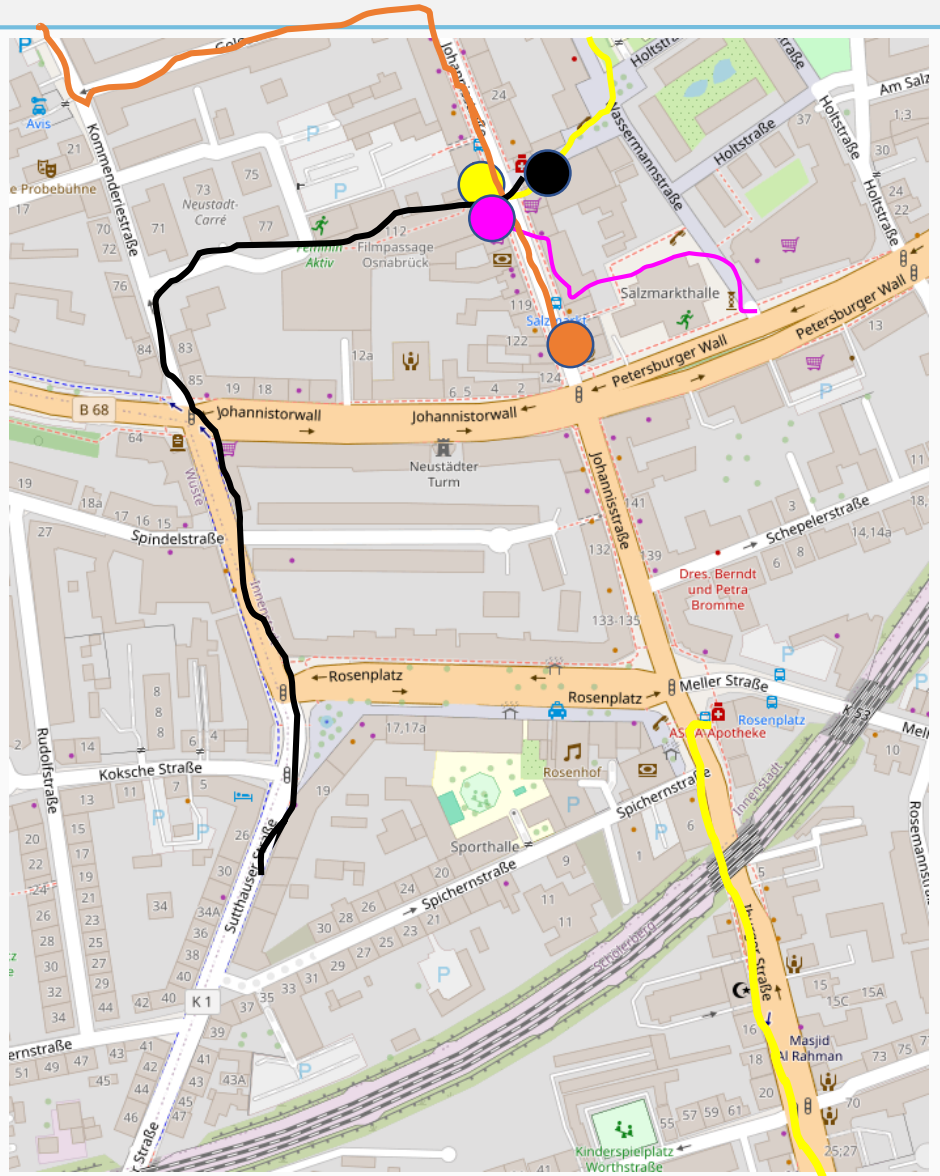
https://esmovilidad.mitma.es/noticias/programa-supermanzanas-de-barcelona (10/04/2024) https://smartcity.ms/leezenflow/ (10/04/2024)
S. Tsubohara (2007). The effect and modification of the Traffic Circulation Plan (VCP)

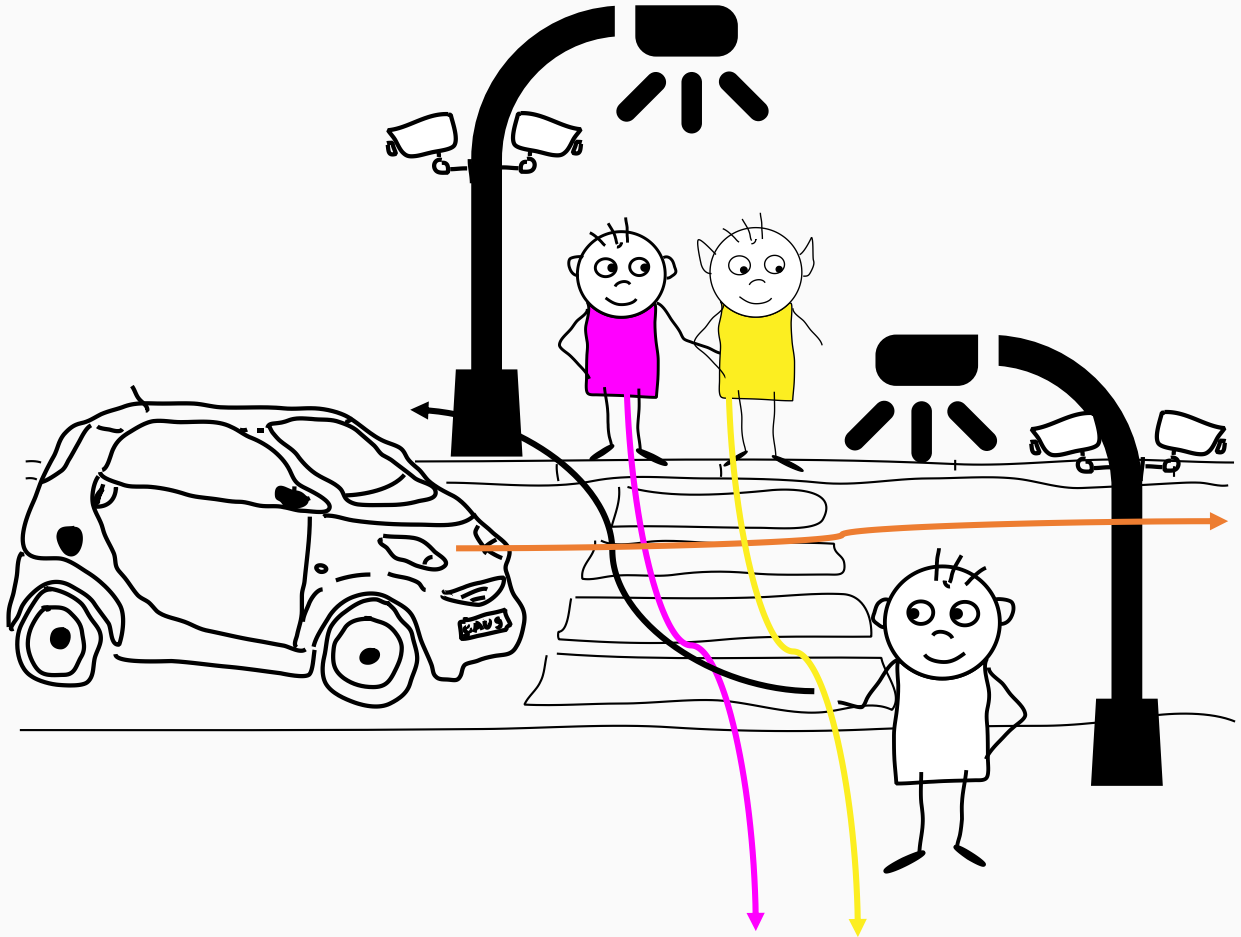
Solutions: Sensor-based traffic simulation - GPS tracker



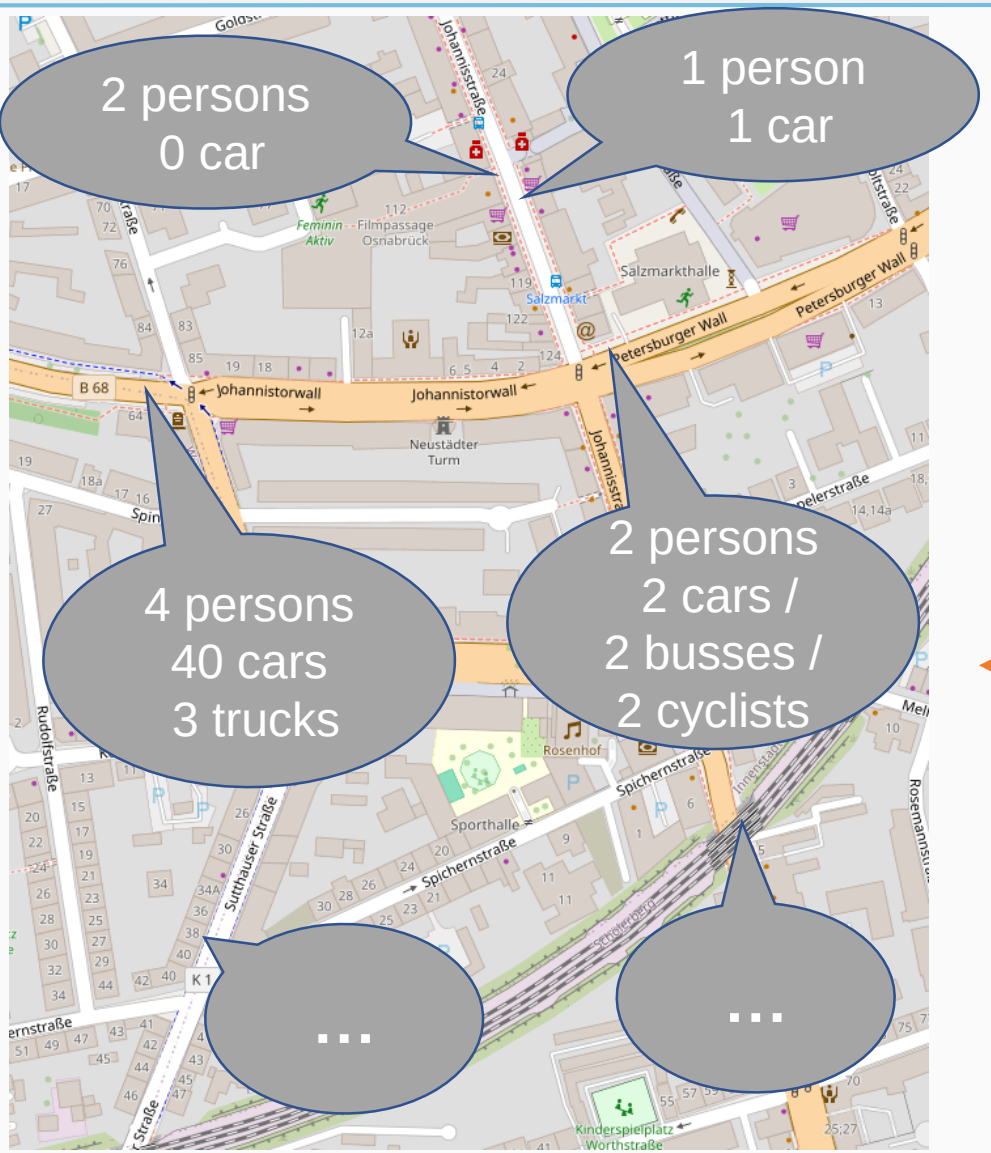


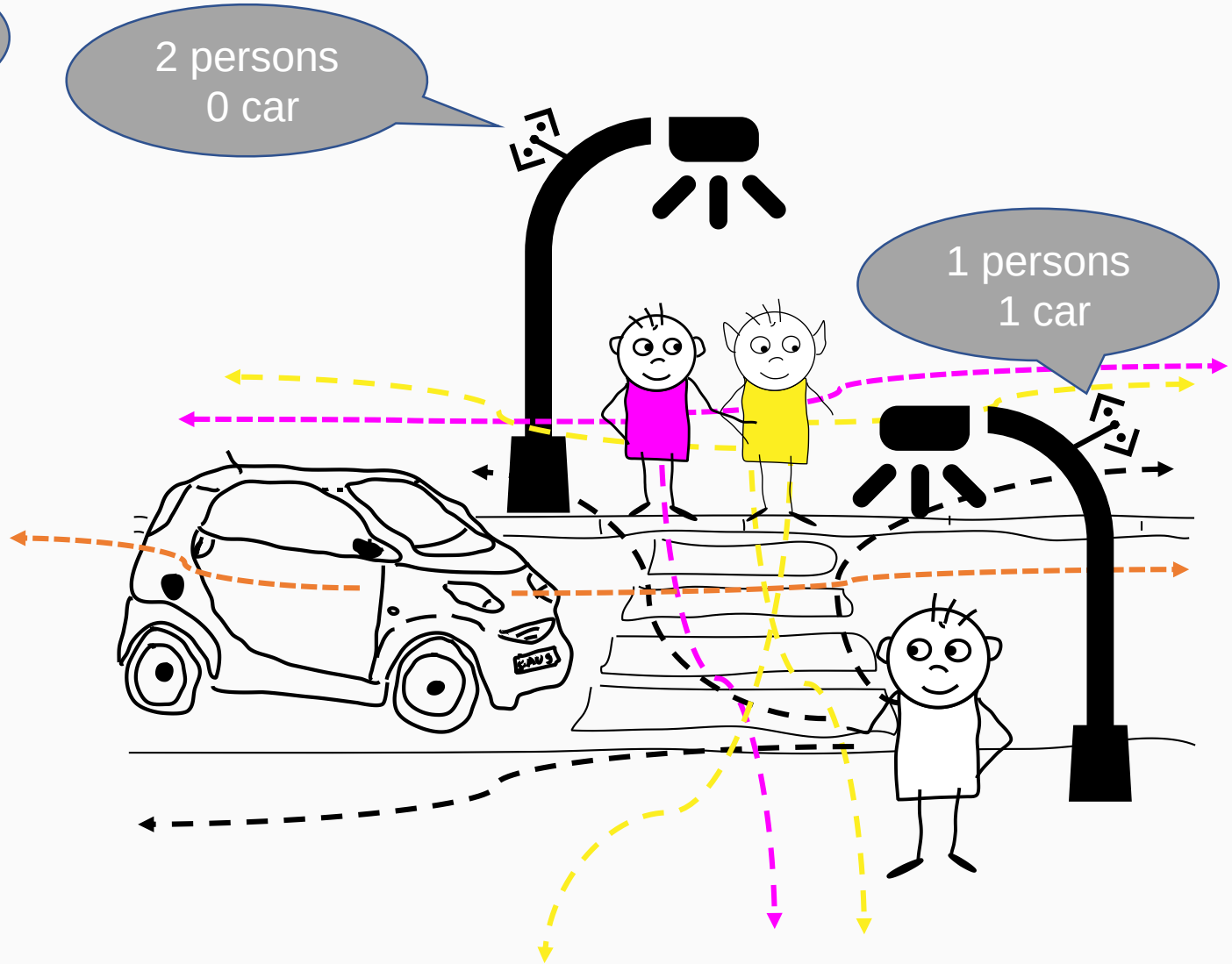
Solutions: Sensor-based traffic simulation - Video cameras





Solutions: Sensor-based traffic simulation - Sensors





Simulating Traffic Networks

Driving SUMO towards digital twins

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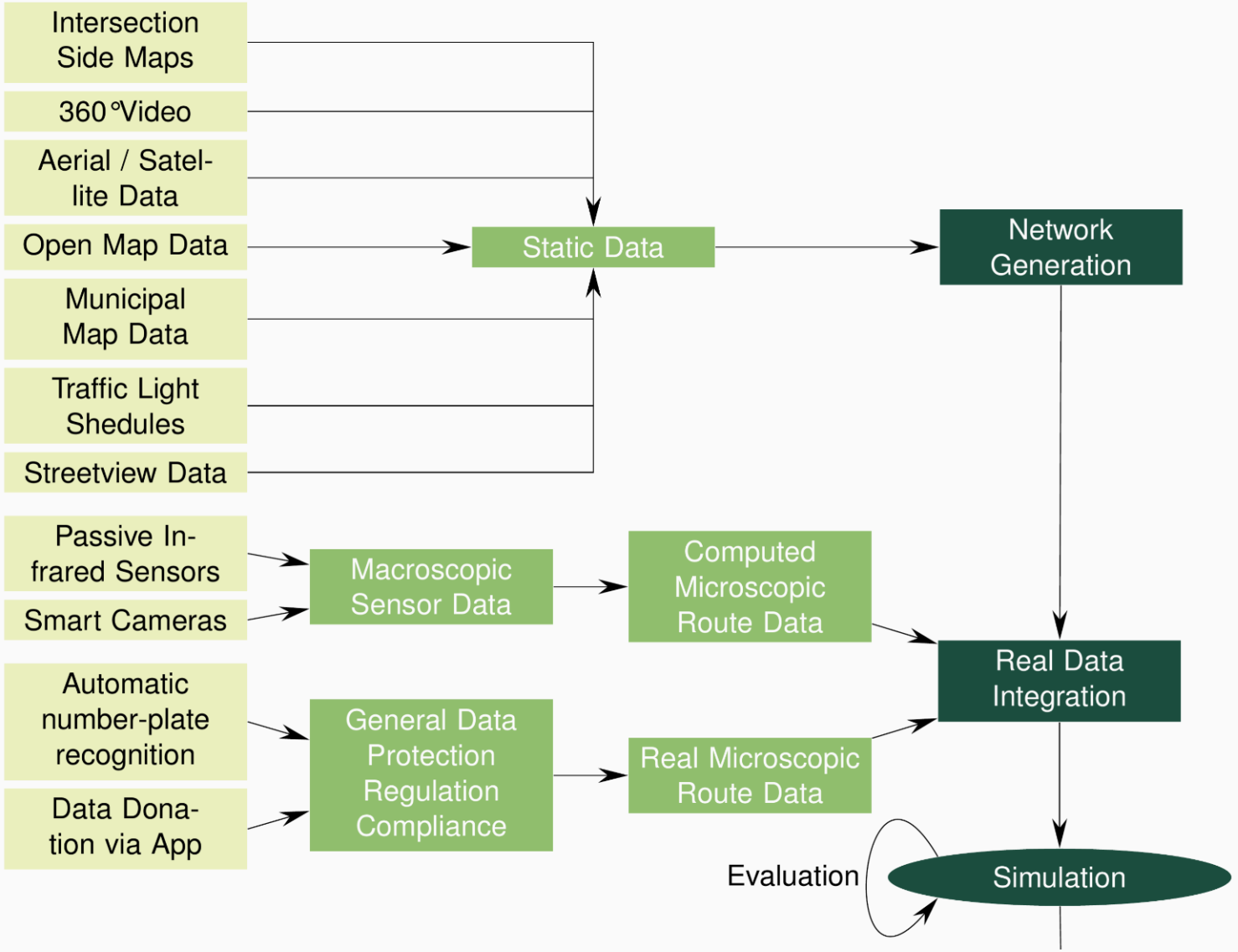
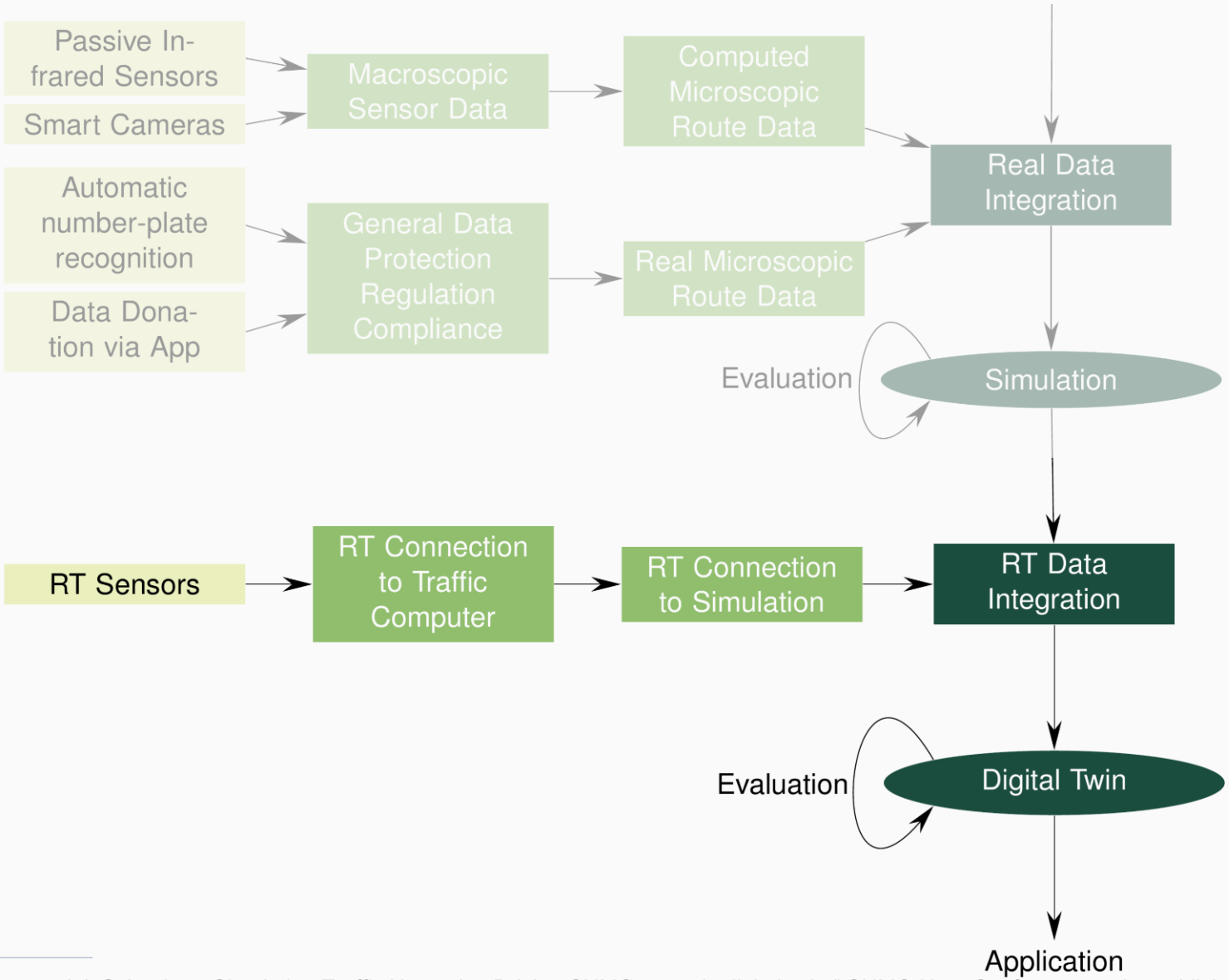


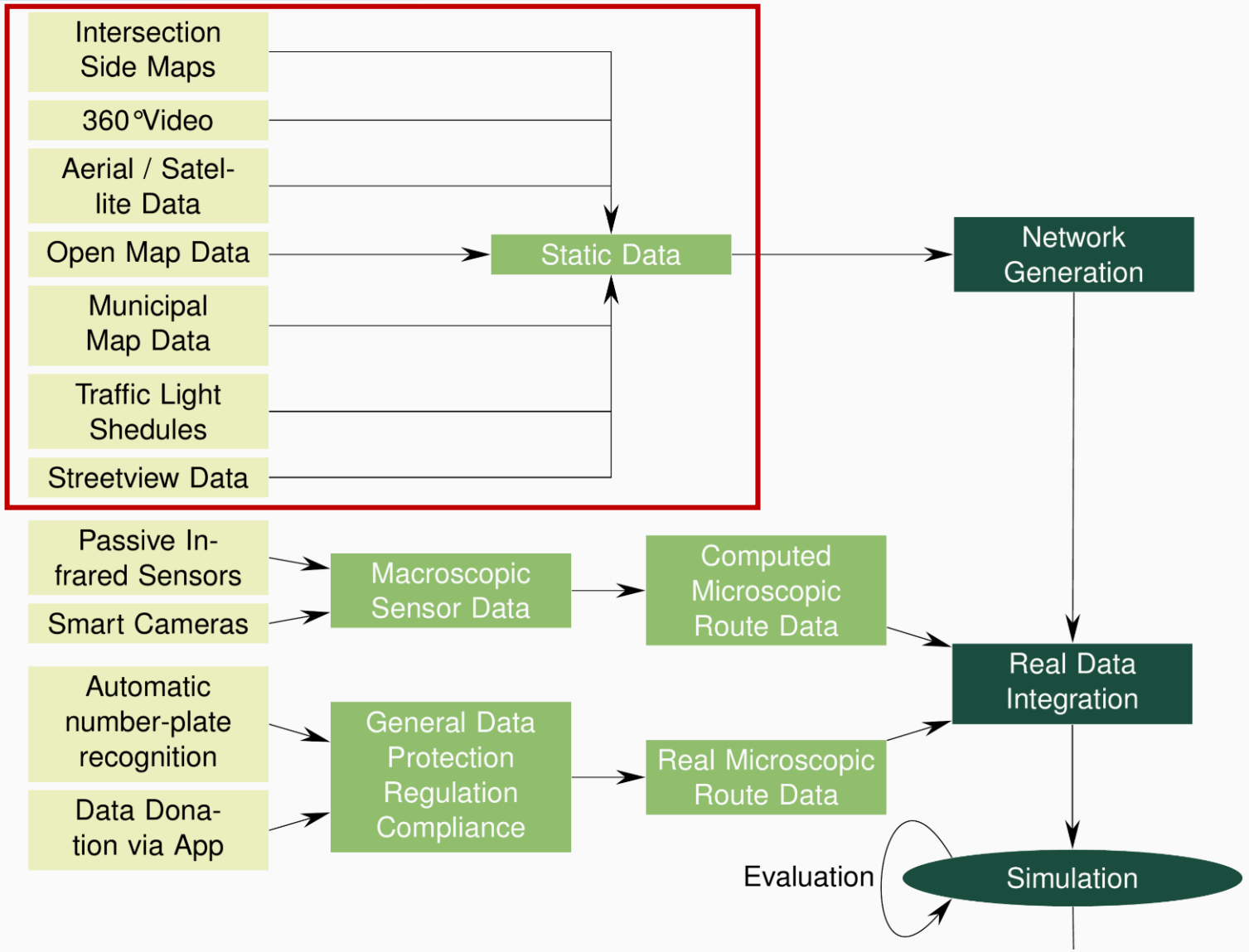
Driving SUMO towards digital twins



Simulating Traffic Networks

Static data

Static data: Sources



Static data: Fusion

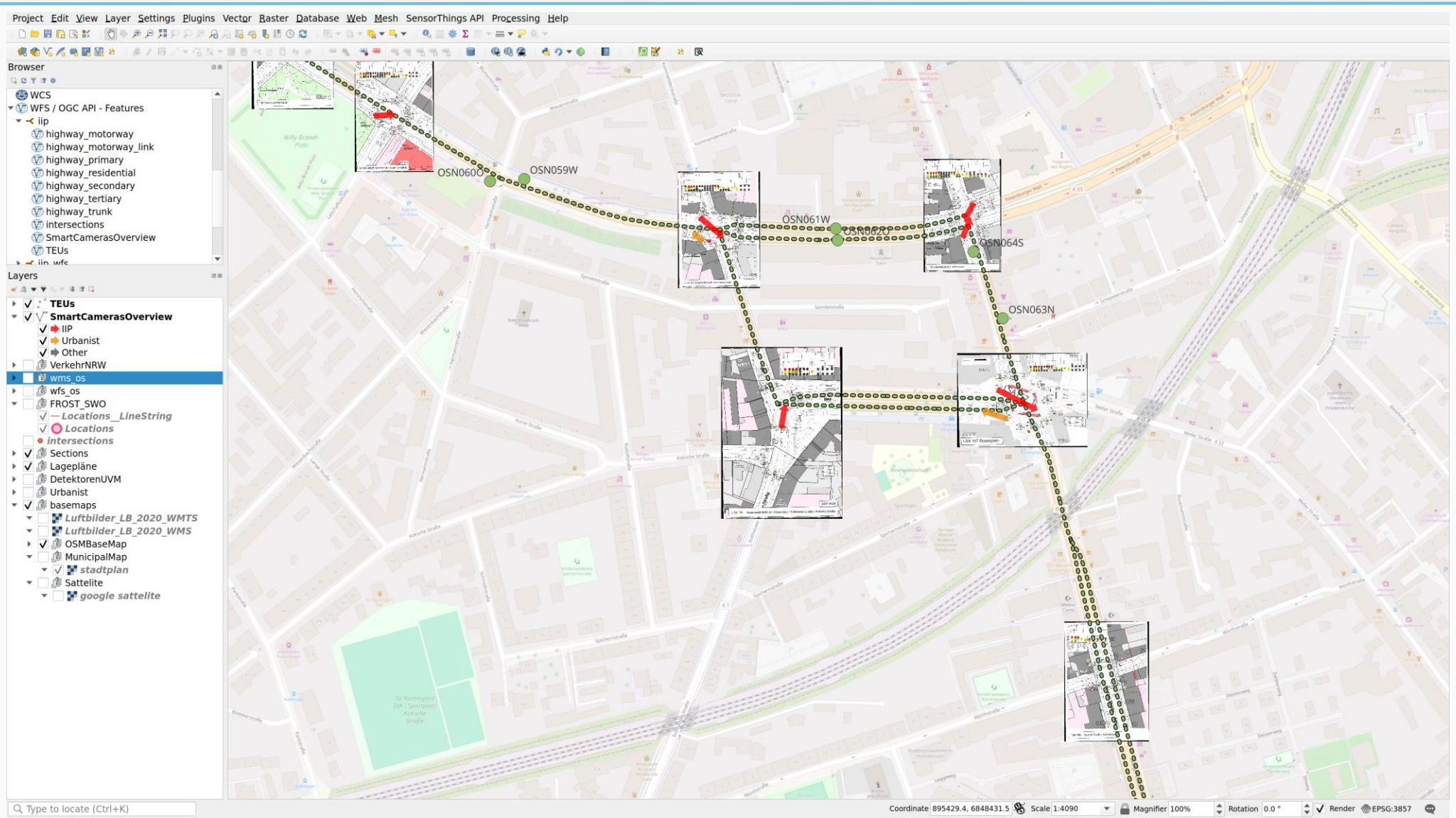
- embedding all data sources in the GIS

- utilization:
  - creation of the traffic network
  - definition of new sensor positions
  - assignment of sensor position, masts, locations
  - ...

- publication as WMS / WFS for integration into other GIS systems

- publication as a website for direct use in the browser

Static data: Fusion

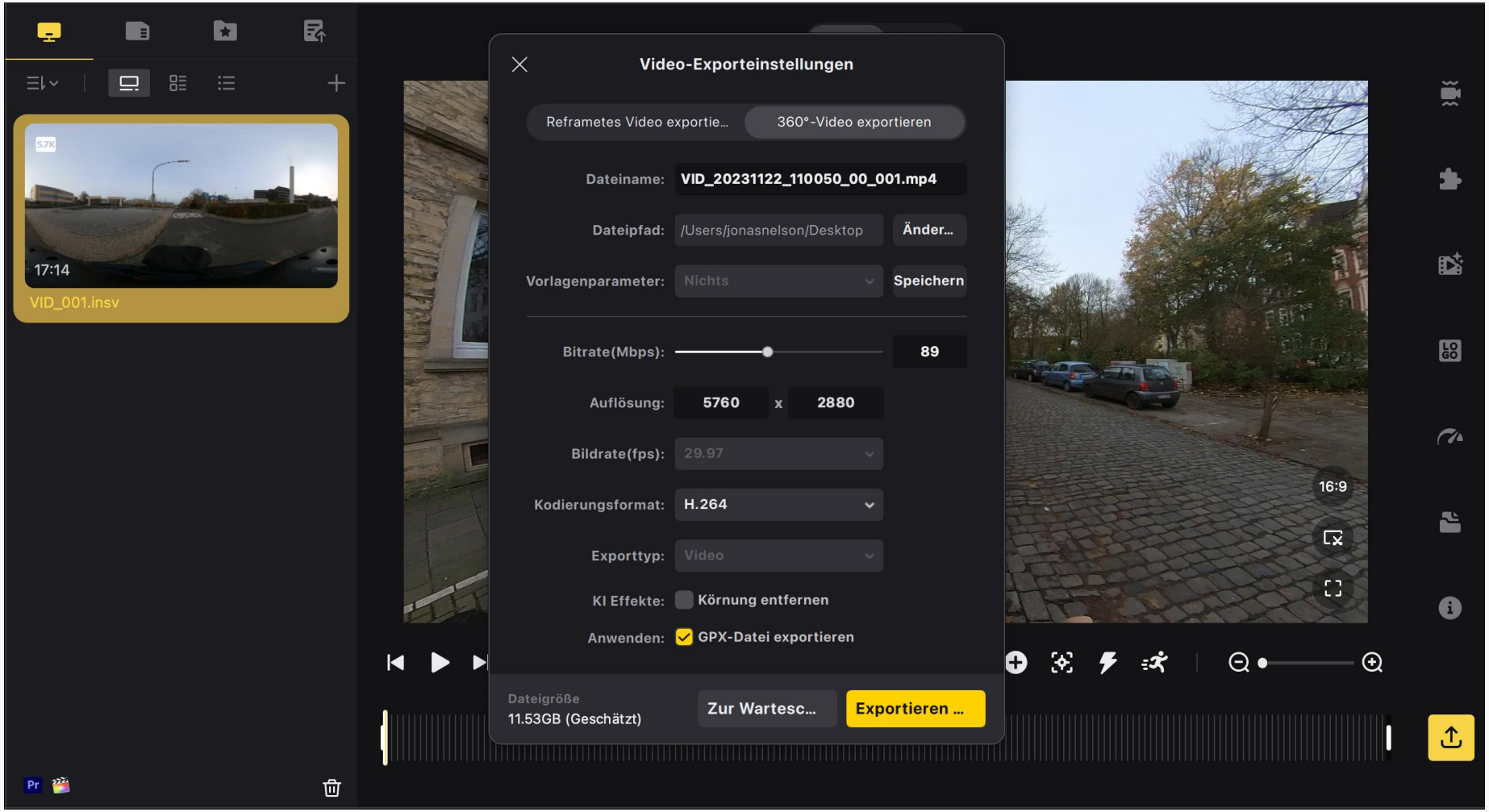


Static data: Network generation

- recording your own 360° videos
- update and correction of OpenStreetMap data
- conversion of OpenStreetMap data to SUMO mesh
- renewed correction of OpenStreetMap data
- conversion of OpenStreetMap data to SUMO mesh again
- final adjustments to the SUMO network
- assignment of the signal programs to the individual signal systems

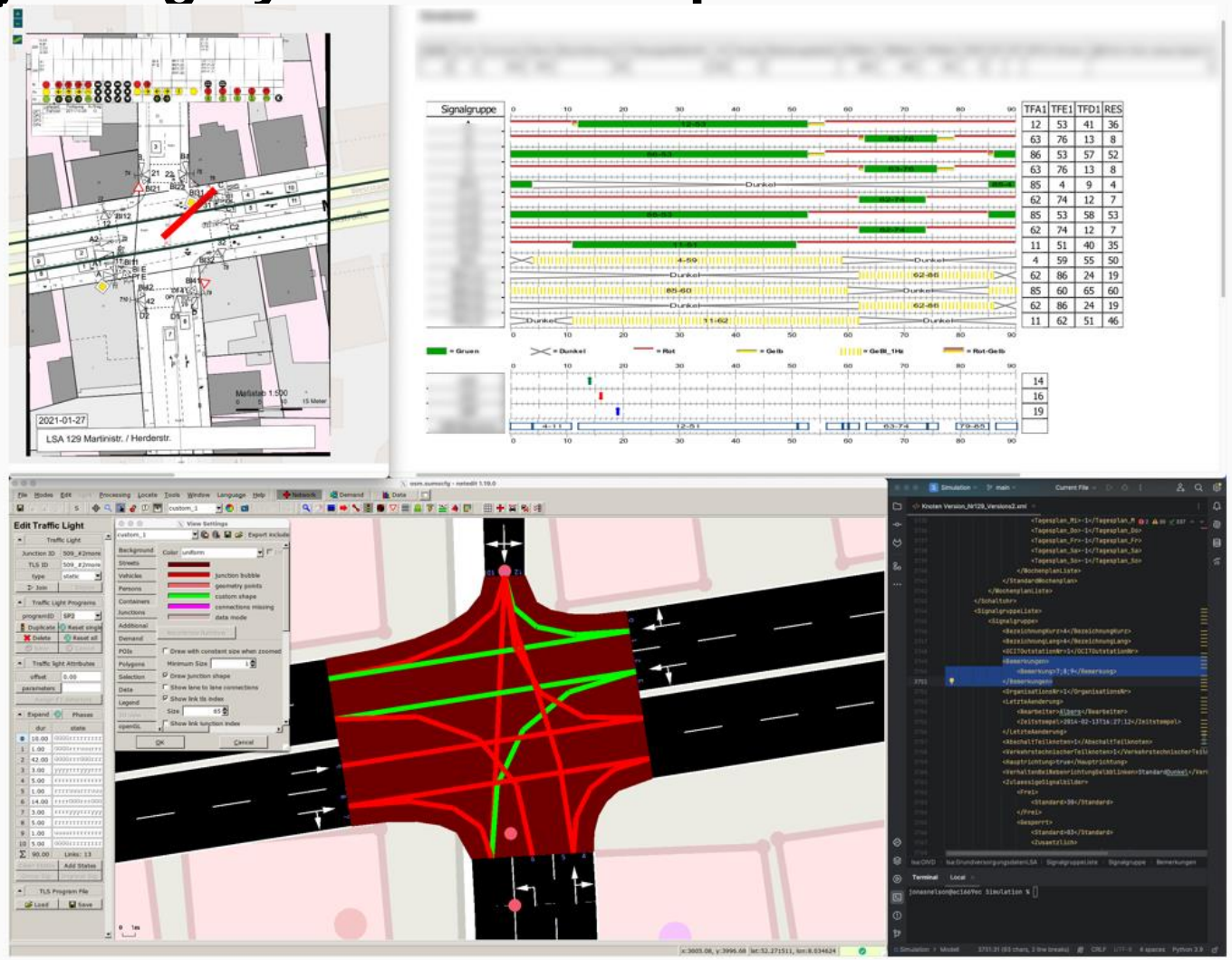
Static data: Network generation

Creation of missing static data



Static data: Signal systems

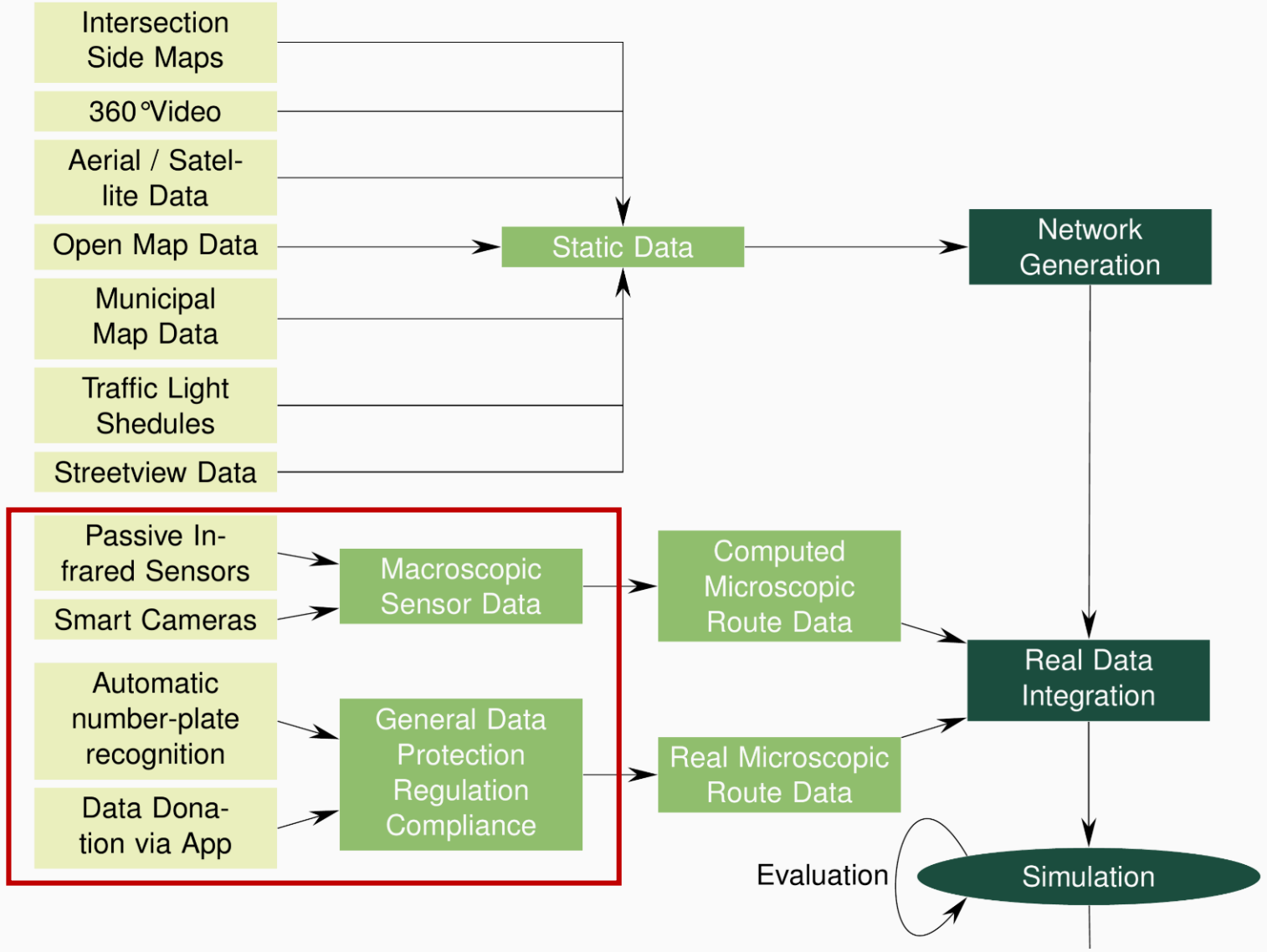
Modeling of signaling systems and dependencies



Simulating Traffic Networks

Dynamic data

Static data: Sources



Static data: Sources

Passive Infrared Sensors

- traffic volume measurement
- measurement of traffic speed
- differentiation of different road users by vehicle length

Smart Cameras

- measurement of turning behavior at individual intersections
- AI-based differentiation of different road users

Further sensor technology for

- public transport: capacity utilization, delay...
- shared mobility: positioning, availability...
- non-motorized individual transport: bicycles, pedestrian walkways...

A. Schaffland, J. Nelson und J. Schöning, „Simulating Traffic Networks: Driving SUMO towards digital twin,“ SUMO User Conference, to be published 2024

Dynamic data: Positioning of smart cameras

Depends on requirements

- turning behavior at intersections
  - two cameras per intersection, each measuring two directions of travel
  - viewing direction diagonally across the intersection
  - traffic light pole

- speed, flow
  - measurement in free flowing traffic
  - viewing direction away from the intersection
  - traffic light pole or lamppost.

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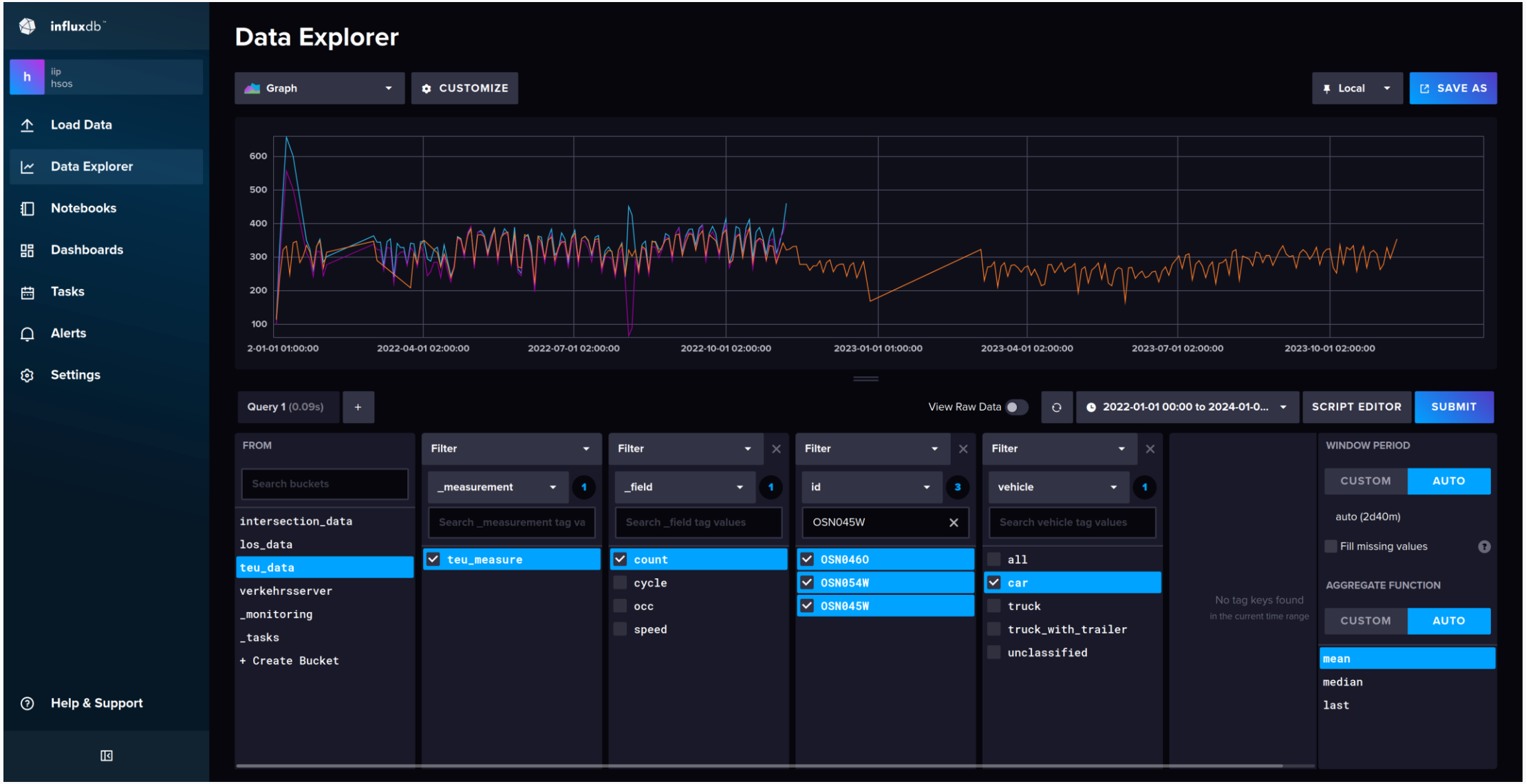
Dynamic data: Data output

- sensors send data to traffic computer
- data is copied to high-performance timeseries database
- SUMO and other applications access the database

Dynamic data: Database



Dynamic data: Routing and demand modeling

- sensors only measure macroscopic count data

- microscopic simulation means
  - simulation of all road users as individuals
  - individuals drive from origin-destination
  - all individuals follow fixed routes

⇨ How can routes be generated from count data?

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Dynamic data: Routing and Demand Modeling

SUMO Demand Modeling Algorithms

- assignment of sensors to positions in the traffic network
- retrieving sensor data for the simulation period from the database
- data cleansing and conversion (routes to lanes, units)
- generation of routes for each vehicle so that
  - # vehicles measured at the measurement points matches the simulation
  - avg. simulated speeds with the avg measured speeds match the measured speeds
  - excess vehicles leave the network at other positions or missing vehicles start at other positions
- estimation or randomization of
  - individual routes and speeds
  - driving behavior: Overtaking, acceleration, safety distances
  - vehicle parameters: dimensions, consumption, environmental impact

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Simulating Traffic Networks

Outlook

Outlook

Next Goals

- collection and fusion of traffic data
- analysis, simulation and forecasting

Motivation

- identification of possibilities for promotion of alternative means of transport
- development of effective solutions to improve traffic flow and mobility in cities
- contributing to the creation of more pleasant and environmentally friendly urban traffic environments

Challenges

- data situation, fusion, metadata
- macroscopic data vs. microscopic simulation

Completely without personal reference

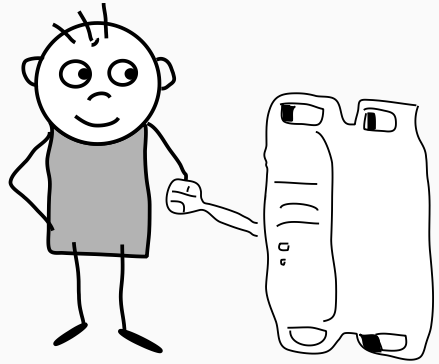
The modern way of drawing

The modern way of drawing - Prompt Engineers: The new artists?

Without any personal reference!

But close to reality!

today



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Q?

A!

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