Evaluating C-ITS

TrafficQuest-TRAIL-TU Delft Seminar 13 Sep 2016

"New Developments in Evaluating ITS"

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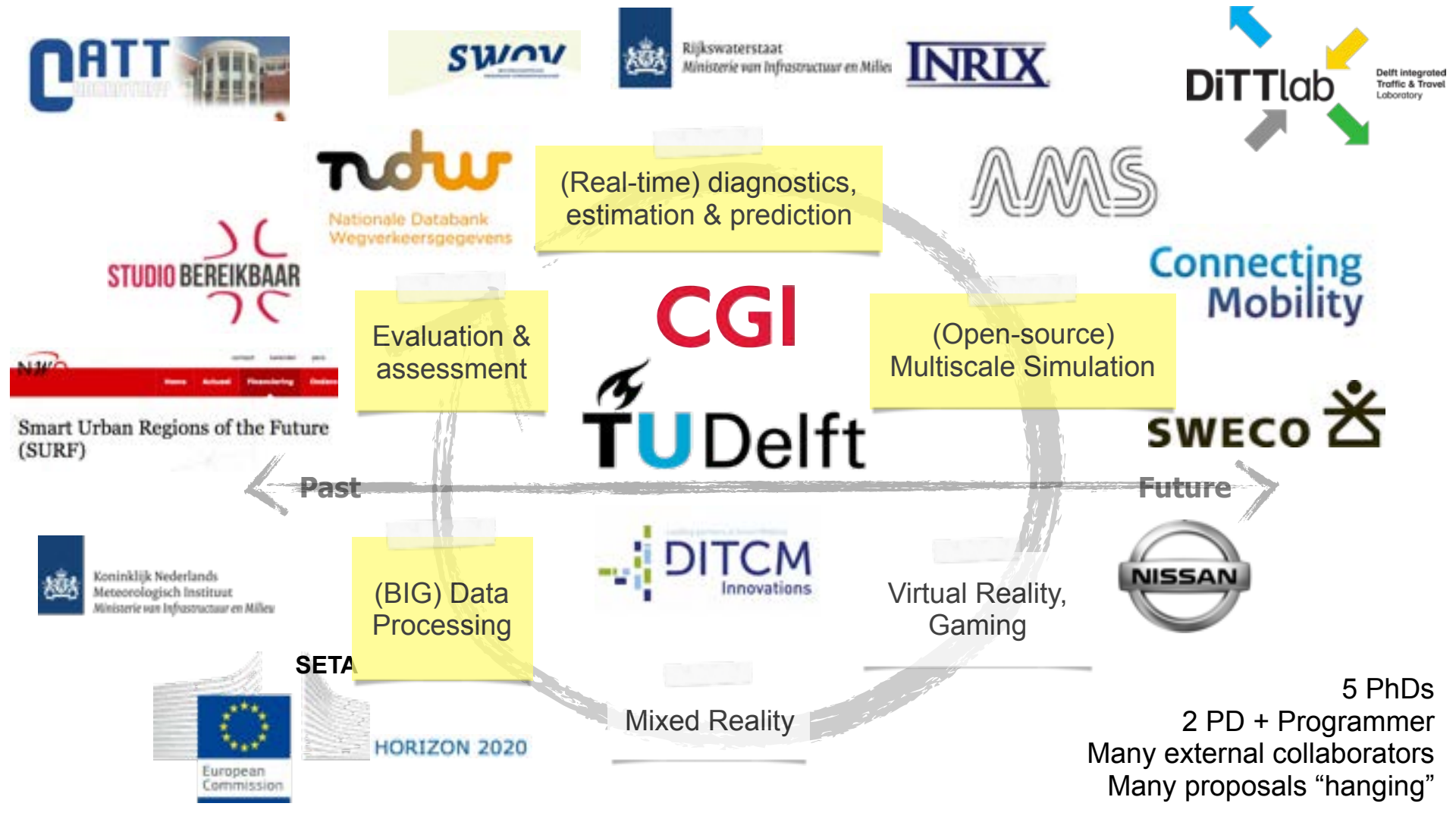
Swinburne / Monash Melbourne

TRAIL
Research School for Transport, Infrastructure and Logistics

TrafficQuest
CENTER FOR EXPERTISE ON TRAFFIC MANAGEMENT

TU Delft

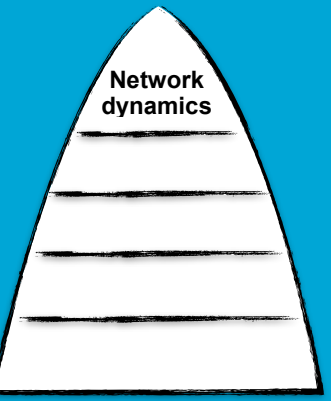
DiTTlab
Delft integrated Traffic & Travel Laboratory



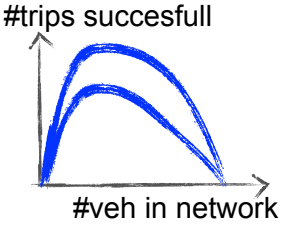
5 PhDs
2 PD + Programmer
Many external collaborators
Many proposals “hanging”

Todays' talk

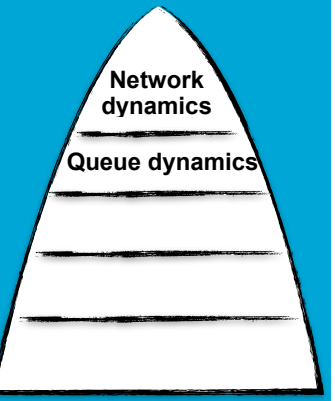
- Motivation
- A cyclic approach to evaluating C-ITS
- Tools for evaluation:
  - Smart ways to access traffic data
  - SimSmartMobility



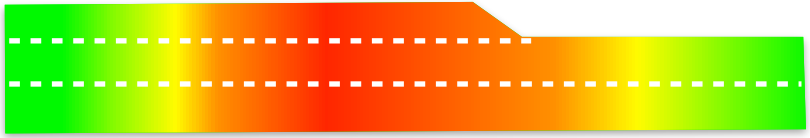
Motivation

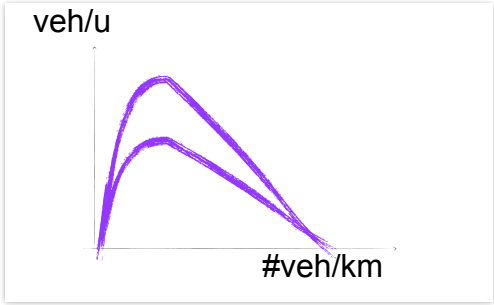


Effect C-ITS and AD in networks?



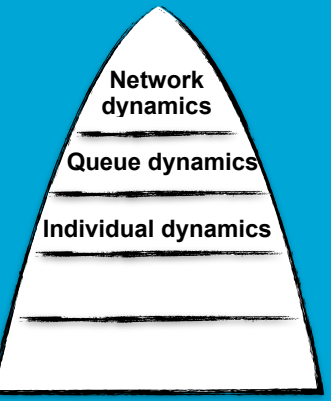
Motivation

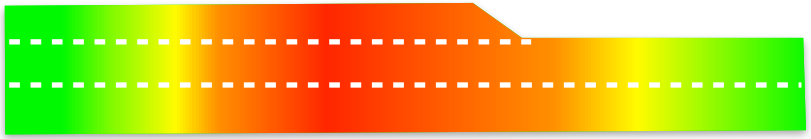


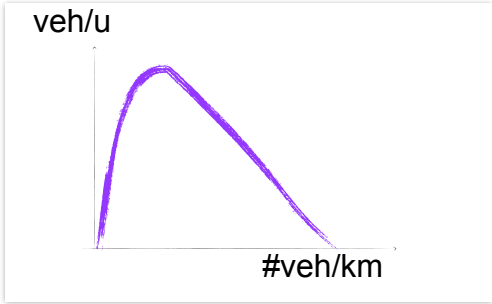


Effect C-ITS and AD on bottleneck capacity?

Motivation

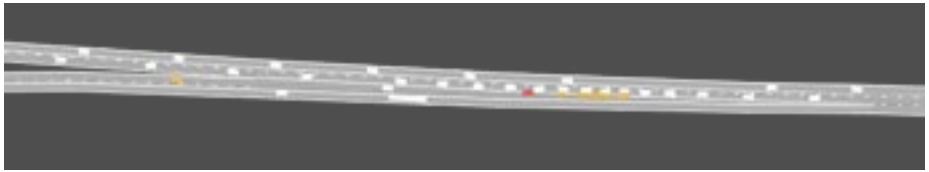


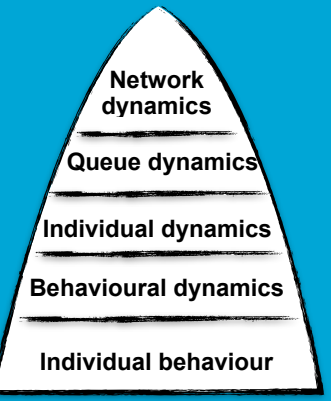




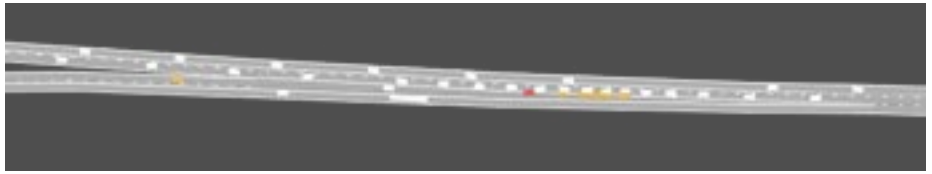
Idealised (automated) drivers: longitudinal behaviour surprisingly good (lateral not so)

Effect C-ITS and AD on vehicle interactions?

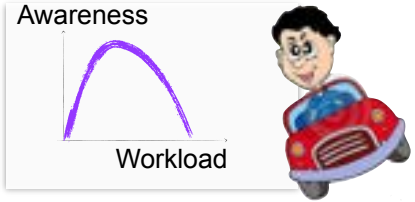




Idealised (automated) drivers: longitudinal behaviour surprisingly good (lateral not so)



Quantitative models to simulate individual behaviour under C-ITS/AR and predict the emergent interactions



Traffic psychology & Human Factors: **qualitative** theories and **conceptual** models for (individual) driving behaviour

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Fundamental problems of evaluating Cooperative ITS and Vehicle Automation

- Drivers WITH "intelligent vehicles" will behave differently (e.g. transition from driving to monitoring)
- Drivers WITHOUT such technology will behave differently when interacting with these intelligent vehicles

http://www.lawandai.com/2016/05/15/nhtsa-and-autonomous-vehicles-part-2/

Fundamental problems of evaluating Cooperative ITS and Vehicle Automation

- Drivers WITH "intelligent vehicles" will behave differently (e.g. transition from driving to monitoring)
- Drivers WITHOUT such technology will behave differently when interacting with these intelligent vehicles

Evidence from:
- Field-tests: high costs, small sample and limited scenarios
- Driving simulator: validity / generalisation

Evidence from:
- Driving simulator (& field-tests?)
- Multi-scale simulation: constraints on what can happen on average

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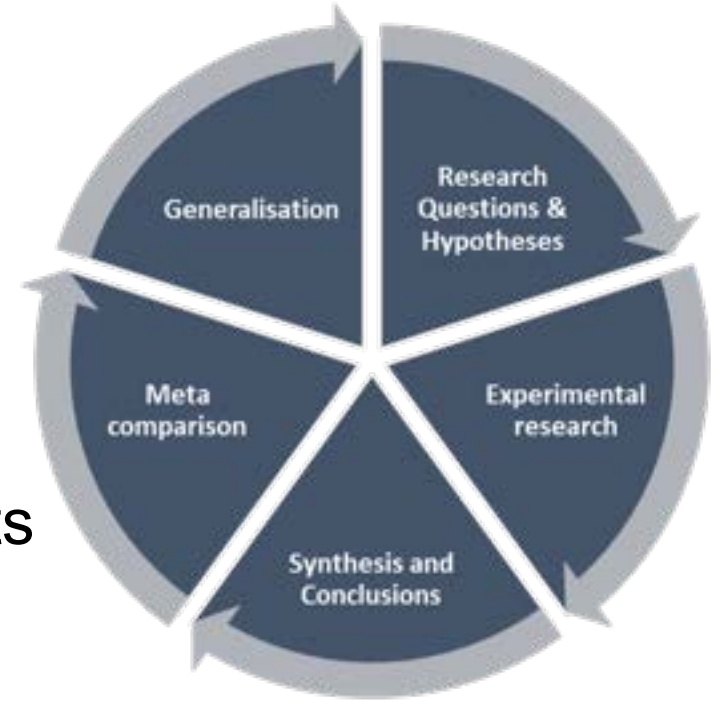
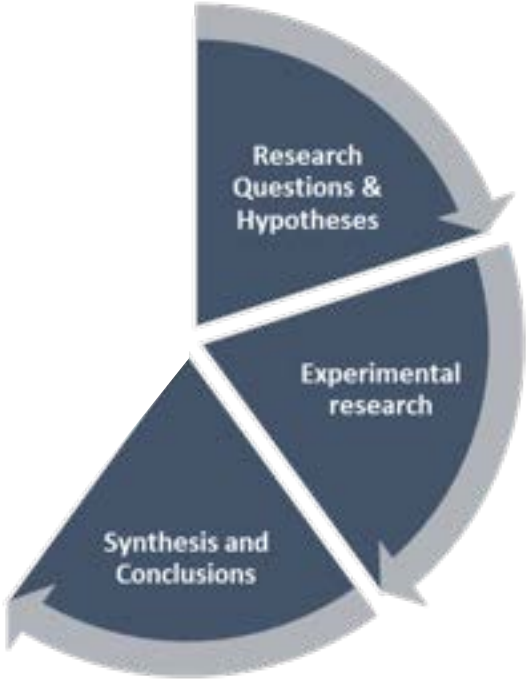
The C-ITS Evaluation Cycle

- Product of the ITS-Effects round-table
- Adds two crucial ingredients:
  - Meta comparing and generalisation of results
  - Cyclic thinking: simulation in the development loop



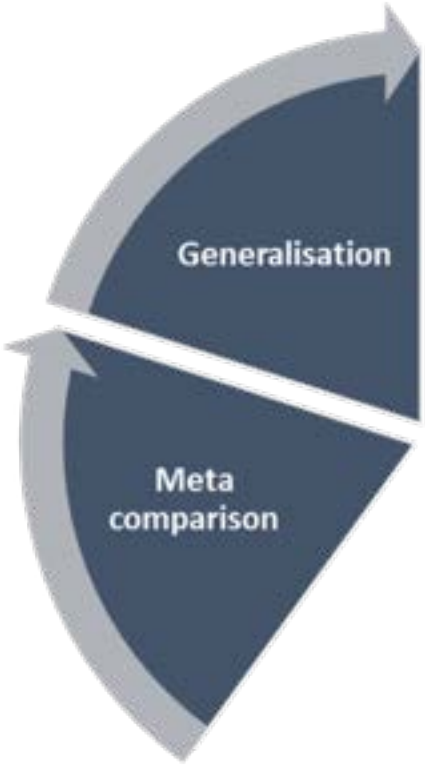
The C-ITS Evaluation Cycle

- Step 1-3
  - Driving sim research, Field-tests & Pilots
  - Use existing methodologies (e.g. FESTA)
  - Increase rigor in exp. design and hypothesis testing



The C-ITS Evaluation Cycle

- Meta comparison & generalisation
  - International comparison results field tests / pilots
  - Simulation in the loop: what if ? (higher penetration, geo distribution, …)
  - Simulation = re-design & incubator new hypotheses



Todays' talk

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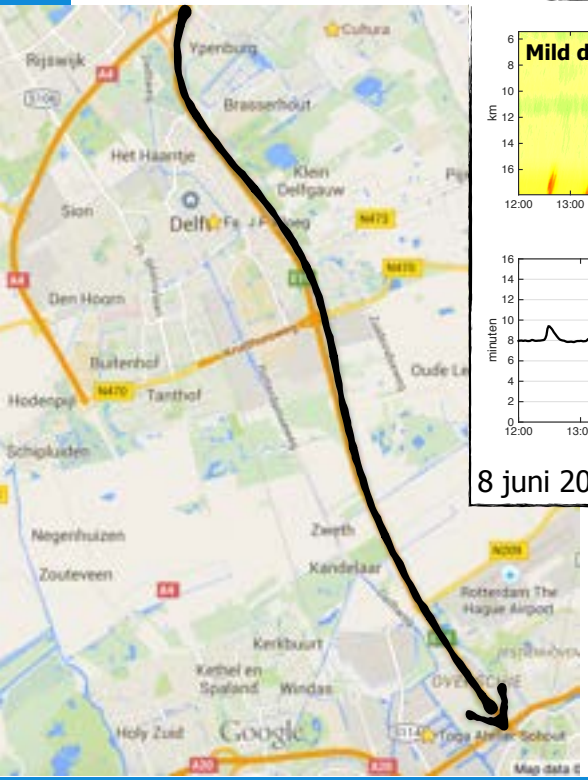
Traffic observatory

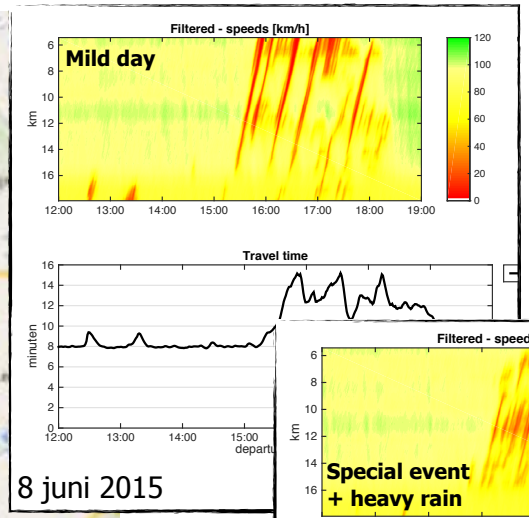
- The overall plan:
  - Phase 1: COSI: make the historical database of NDW “intelligent” so you can search for information
  - Phase 2: Develop multi scale traffic state estimators
  - Phase 3: Develop Multi-scale demand estimators
  - Phase 4: Develop simulation and prediction capabilities

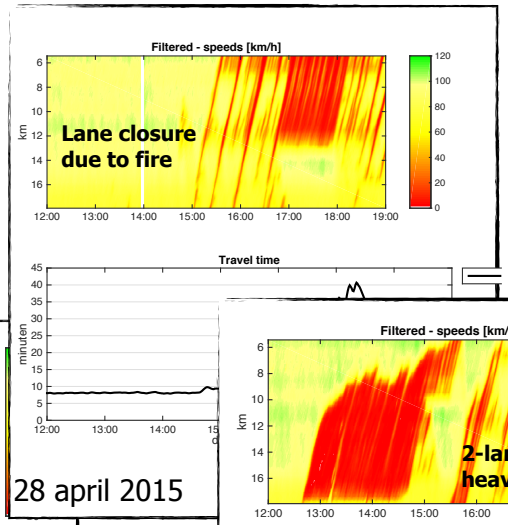
- Phase 2-3 (+ bit of 4): STW proposal MiRRORS (still) under review

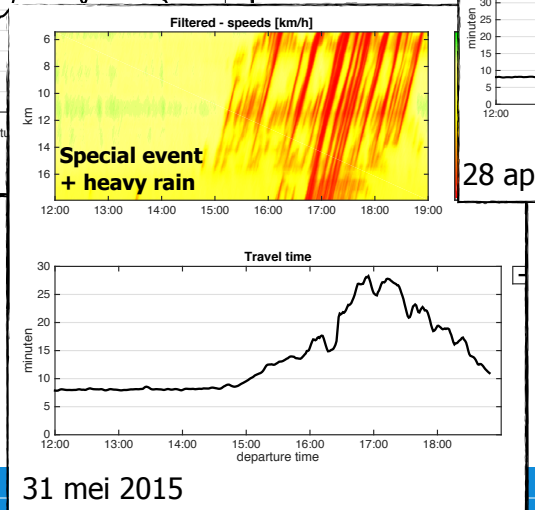
Selecting data for simulation studies tough

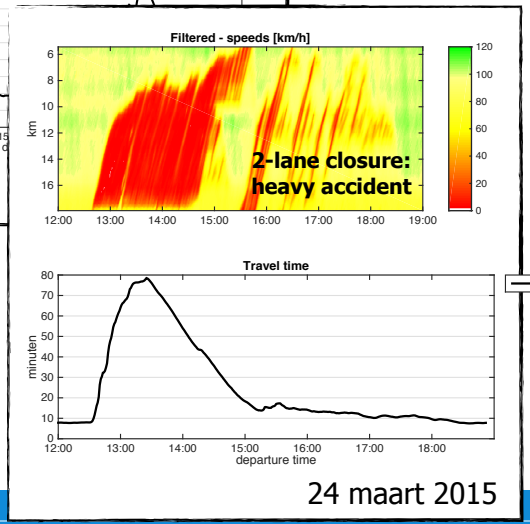
Limited search options supposes you know where and when you want to look





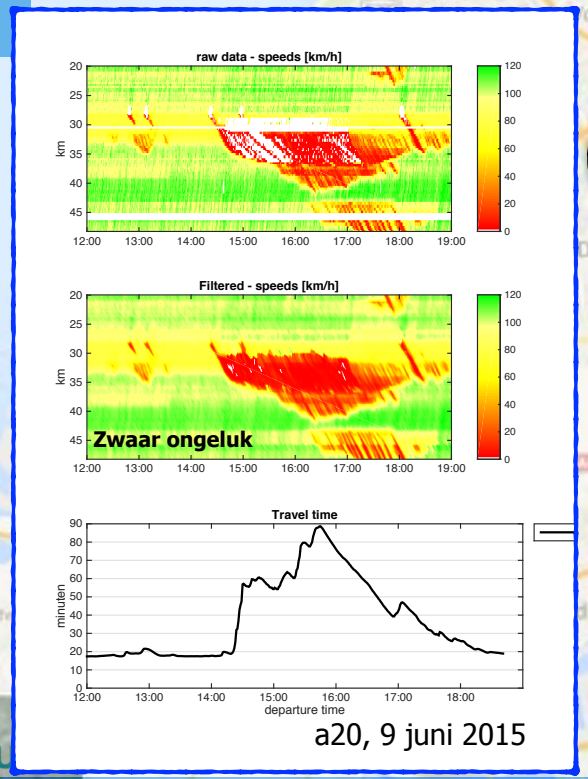


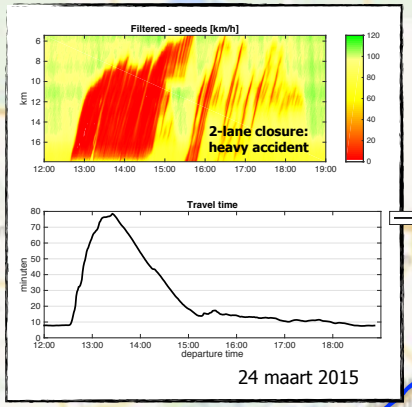


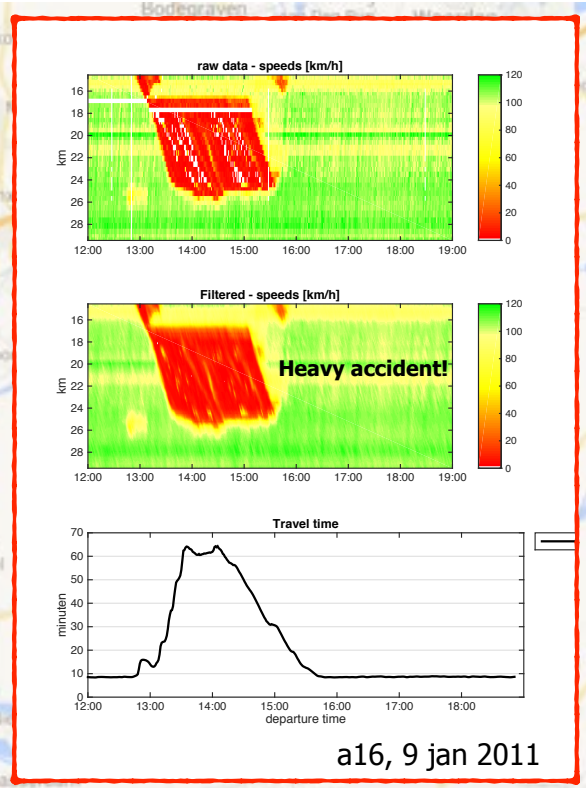


An intelligent historical database

Fast search one abstraction level higher: traffic patterns and meta data







Classification method 1: using image features

Manually classify traffic situations to similar categories

(available) Metadata

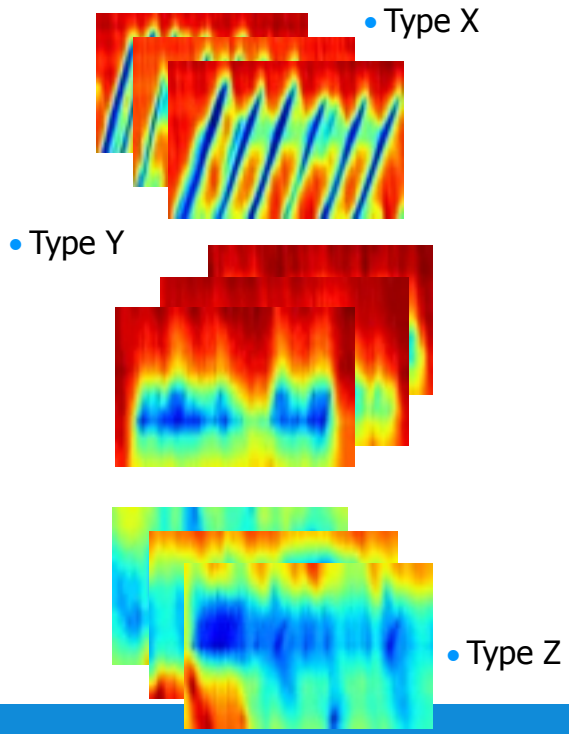
from databases / GIS:

- Date & time
- Geo & digraph info
- Weather
- Incidents / events
- etc

based on dynamic data

- Vehicle loss hours
- Travel time distribution
- data quality
- % trucks
- demand patterns
- etc

clustered congestion images

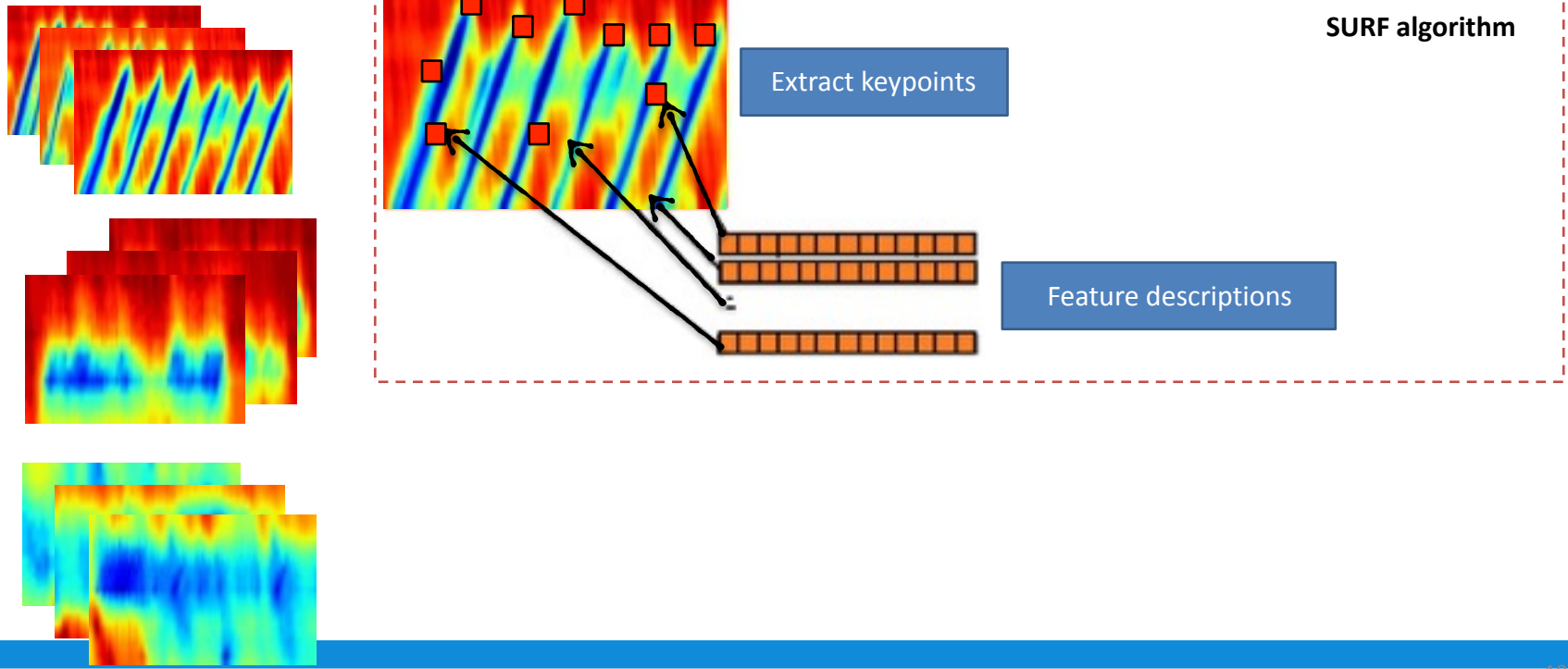


These images may have
- different sizes
- different resolutions
- different wxh ratios

they must have
- similar colormaps
- similar ratio time/space (shockwave speeds)

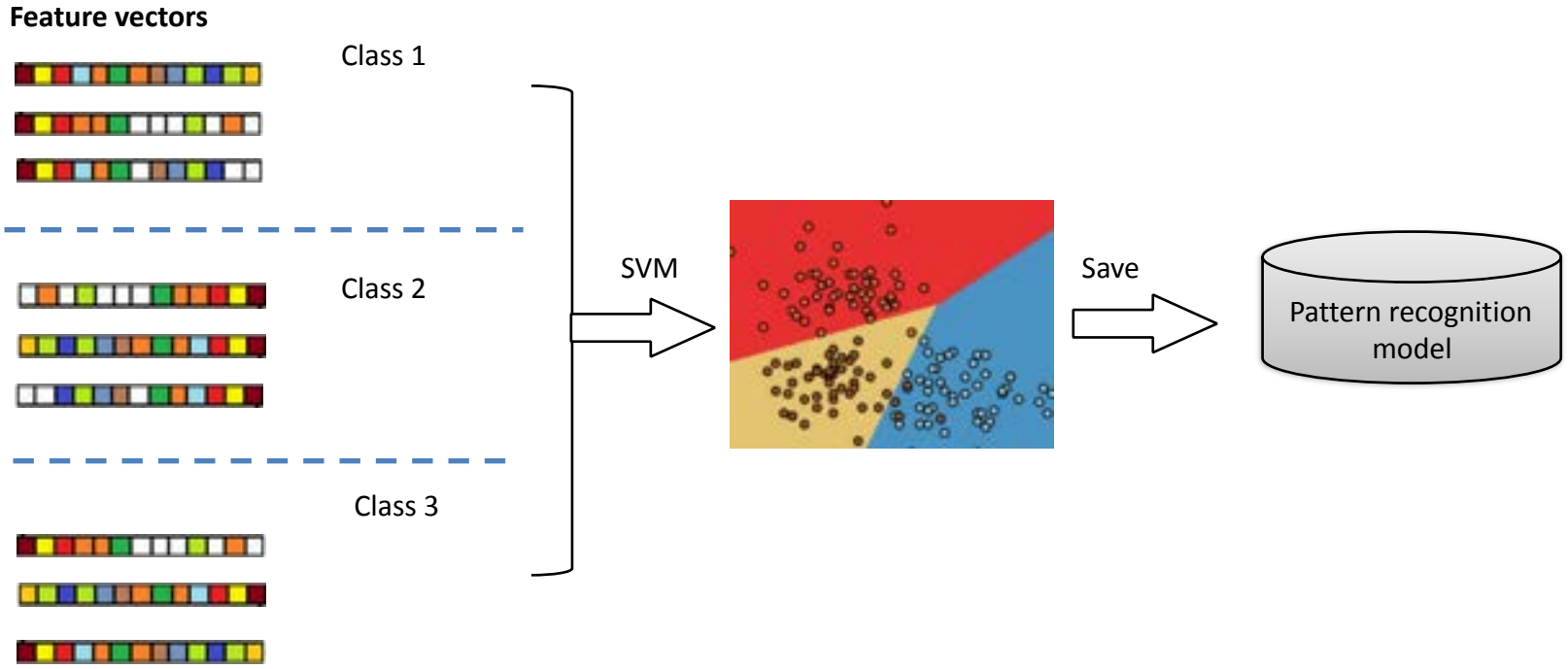
Classification method 1: using image features

Decompose patterns in a "bag of features" (around so-called keypoints)



Classification method 1: using image features

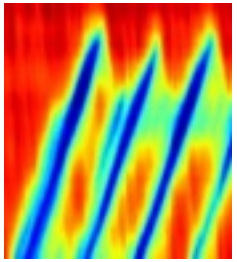
Construct histograms of what's in these bags to train an SVM classifier …



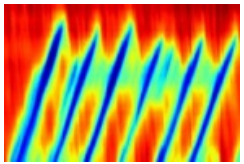
Classification method 1: using image features

… that can be used to classify unseen patterns

Unknown pattern

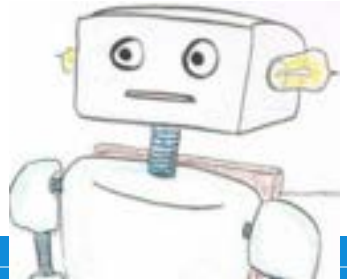


Pattern Type X



unravel in “features”

Classify



Pattern recognition model

Iterative process

1. Manual (re) classification
2. Training
3. Testing
4. Back to 1 until satisfied

Classification method 2: using base shapes

Manually classify traffic situations to similar categories

(available) Metadata

from databases / GIS:

- Date & time
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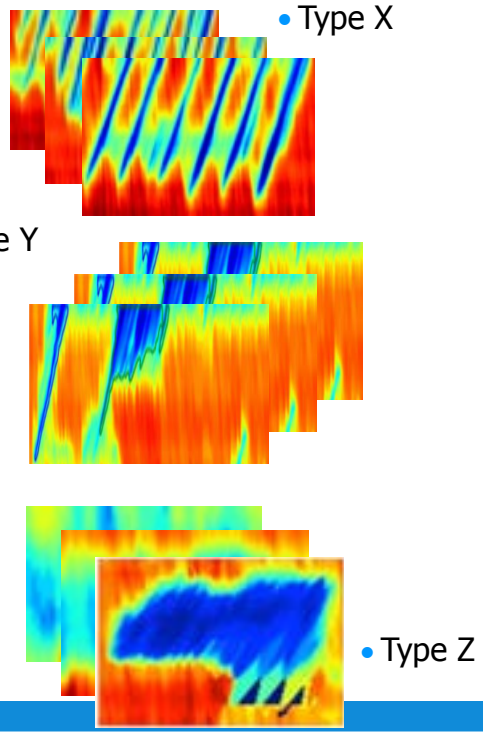
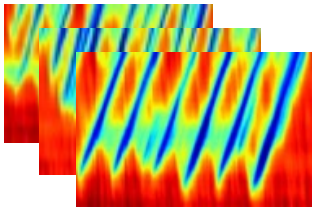
clustered congestion images

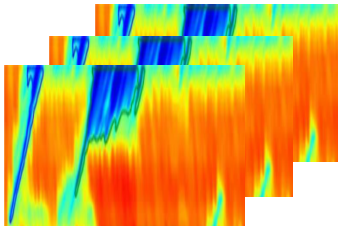


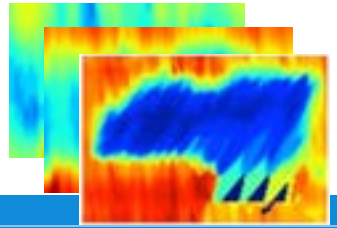
These images have
- common recurring archetypes/shapes
- different sizes

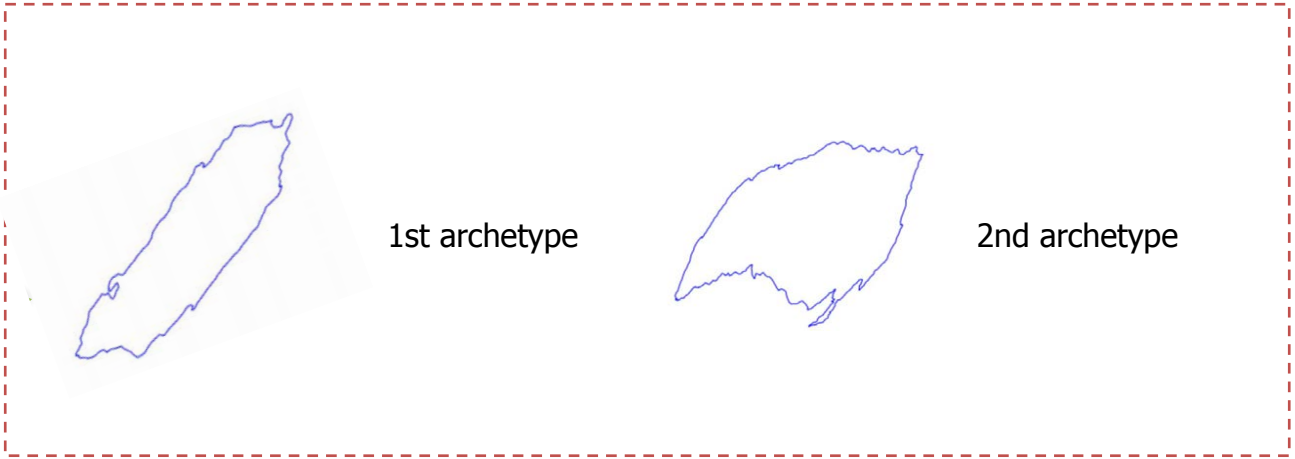
Classification method 2: using base shapes

Identify distinct archetypes/shapes from the patterns
(another way of mimicking how humans recognise faces)



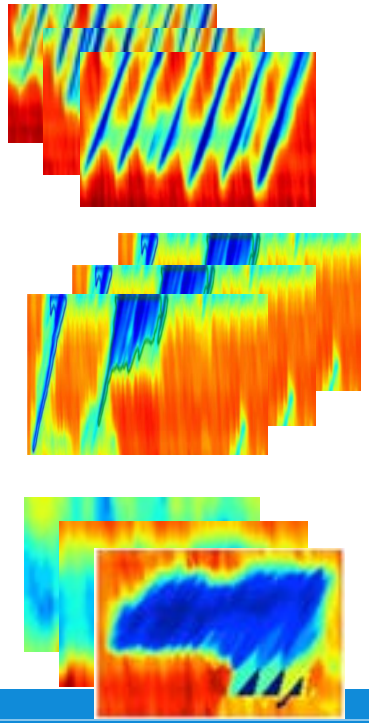






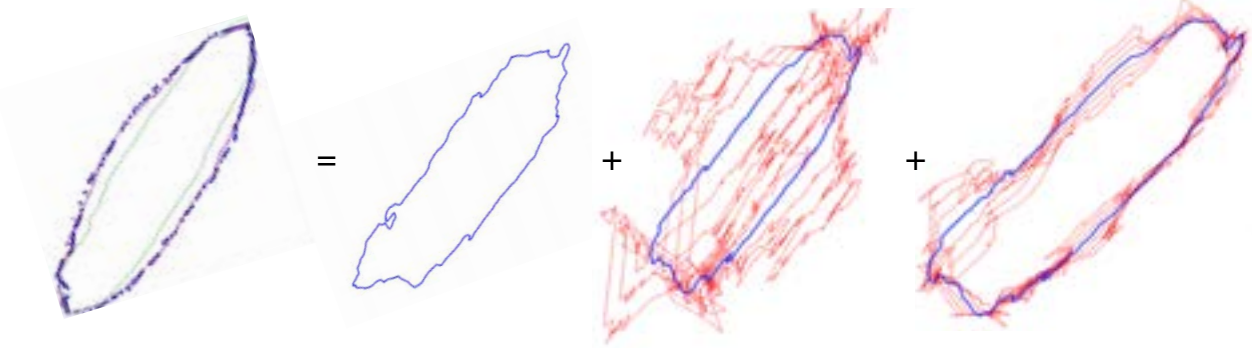
Classification method 2: using base shapes

Figure out possible variations around these base shapes



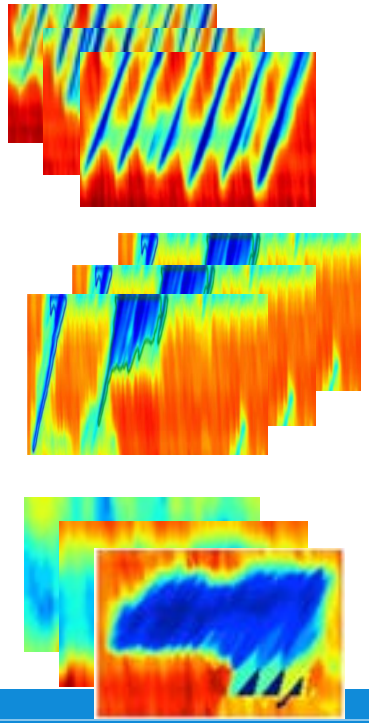
Statistical Shape Model

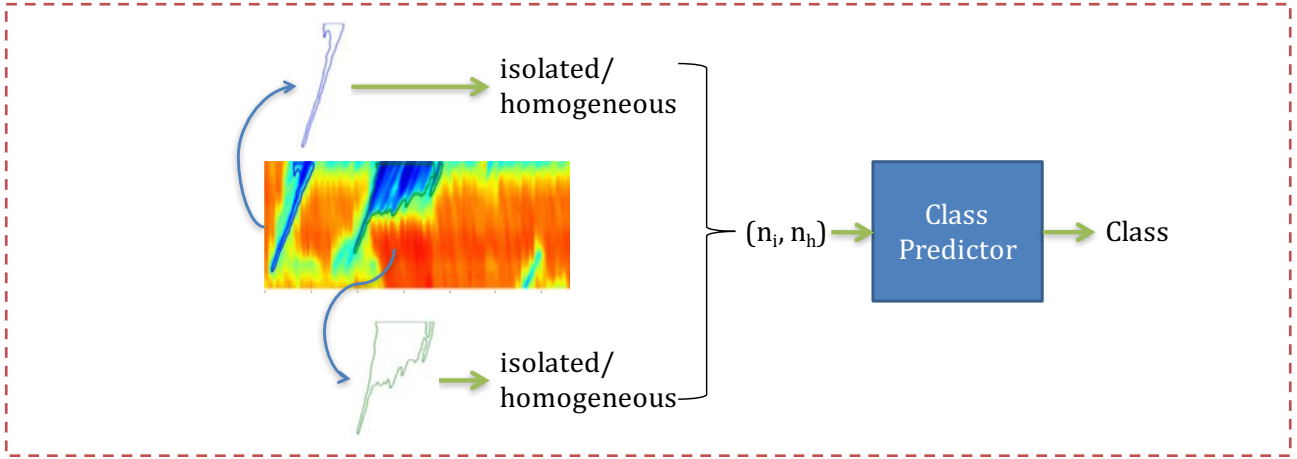
mean shape 1st component 2nd component



Classification method 2: using base shapes

Construct histogram of base shapes in images to train a classifier …

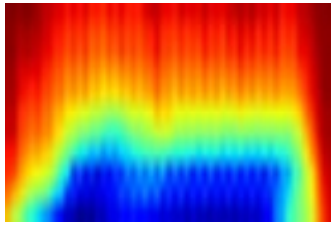




Superfast searching through traffic patterns

… that can be used to classify unseen patterns

Unknown pattern



2D feature vector, (n_i, n_h)

Iterative process

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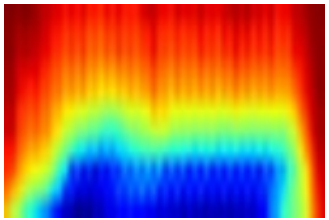
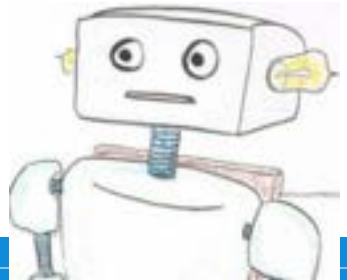
Pattern Type X



Classify



Pattern recognition model

Demo

Todays' talk

- Motivation
- A cyclic approach to evaluating C-ITS
- Tools for evaluation:
  - Smart ways to access traffic data
  - SimSmartMobility

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SimSmartMobility

- Simulation toolkit to evaluate C-ITS (Smart Mobility)
- Key developments:
  - HLA compliant (but max faster/scalable) event-based sim architecture (IMB)
  - DSOL/OpenTrafficSim multi-scale (and in time multi-modal) simulation framework
  - Standardisation interfaces to model input, output and real-time state
- Three use cases (end of 2016)
  - 2 Urban: GLOSA and Traffic Control Optimisation
  - 1 Freeway: controlling wide moving jams

We are in it for the long term:

- Period 2016-2019
- Collaboration Research institutes, Market & Public authorities
-

Connecting Mobility

TNO innovation for life

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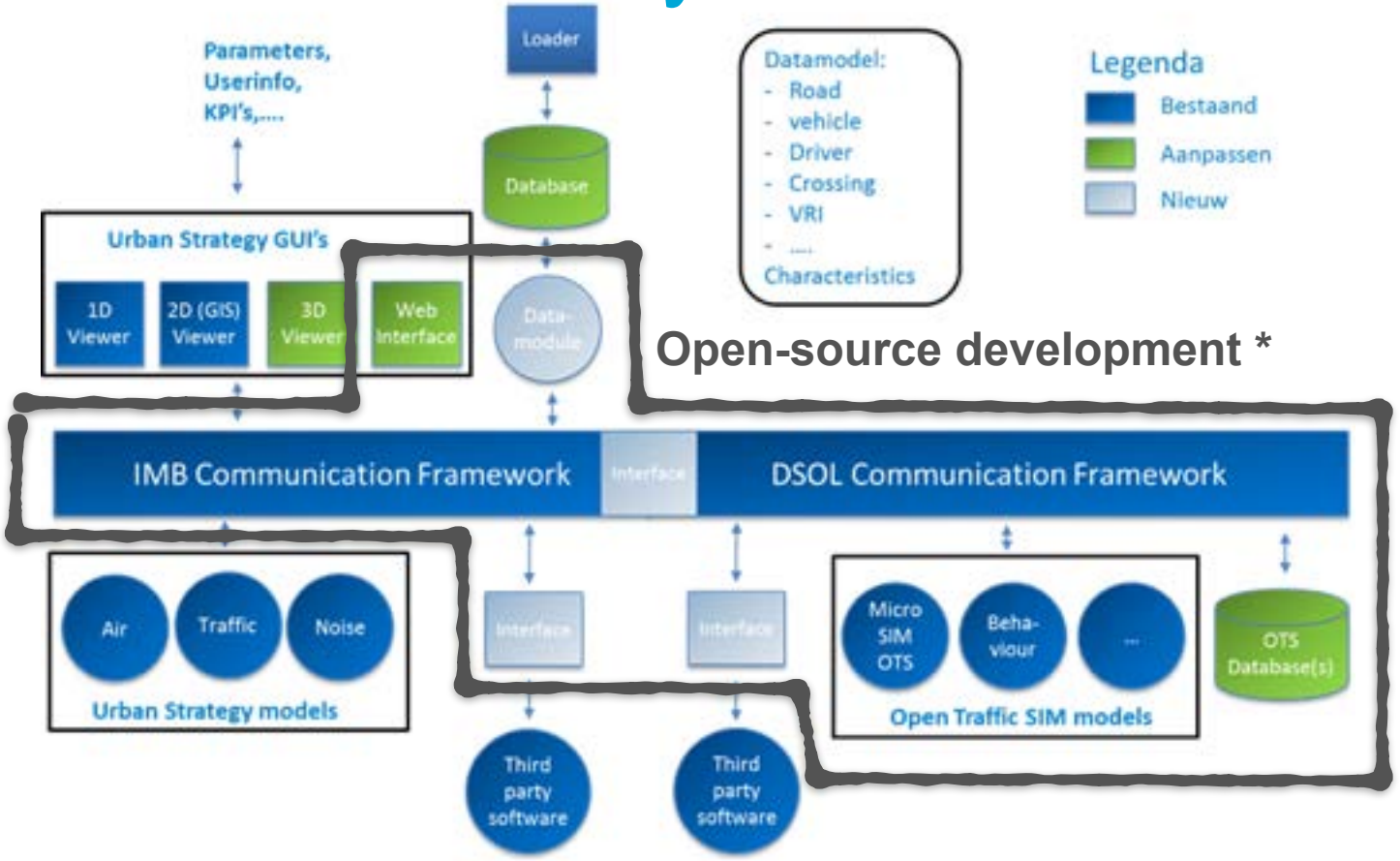
SimSmartMobility



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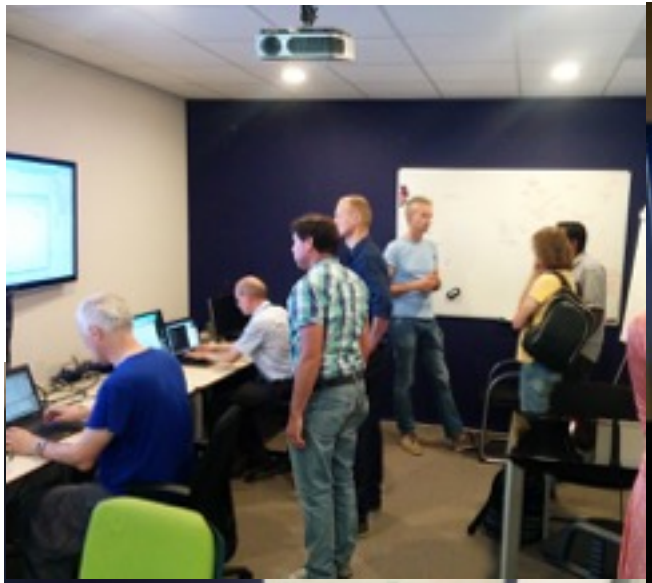

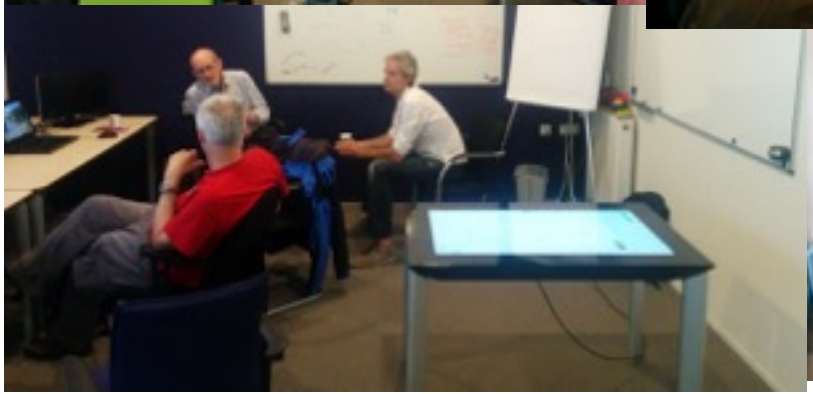

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Thanks!