Real-Time Queue Estimator for Signalised Intersections Based on Detector Data

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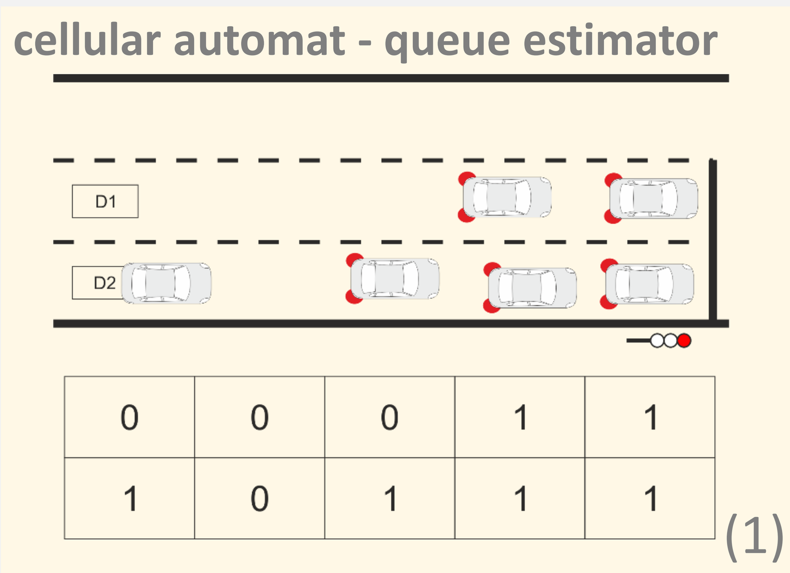
Objective

With the real-time queue estimator (QE) it is possible to easily estimate a queue length at a traffic light (TL) in real time. The queue length could be estimated very precisely up to the most distant sensor with the aid of real-time data about TL sensors (e.g. induction loops, infrared detectors) and TL signal state. The queue length information can be used to calculate a leading time (green) required to reduce the queue length for e.g. approaching public transport or emergency vehicles. This in turn enables precise intervention in the TL control to give priority to vehicles while at the same time minimising the disruption this causes to the general traffic flow. Using the queue length for a GLOSA (Green Light Optimal Speed Advisory) service is another interesting possible area of application, as this additional information can be used to improve the GLOSA advice. The QE can also be used to determine the number of vehicles in a road section.

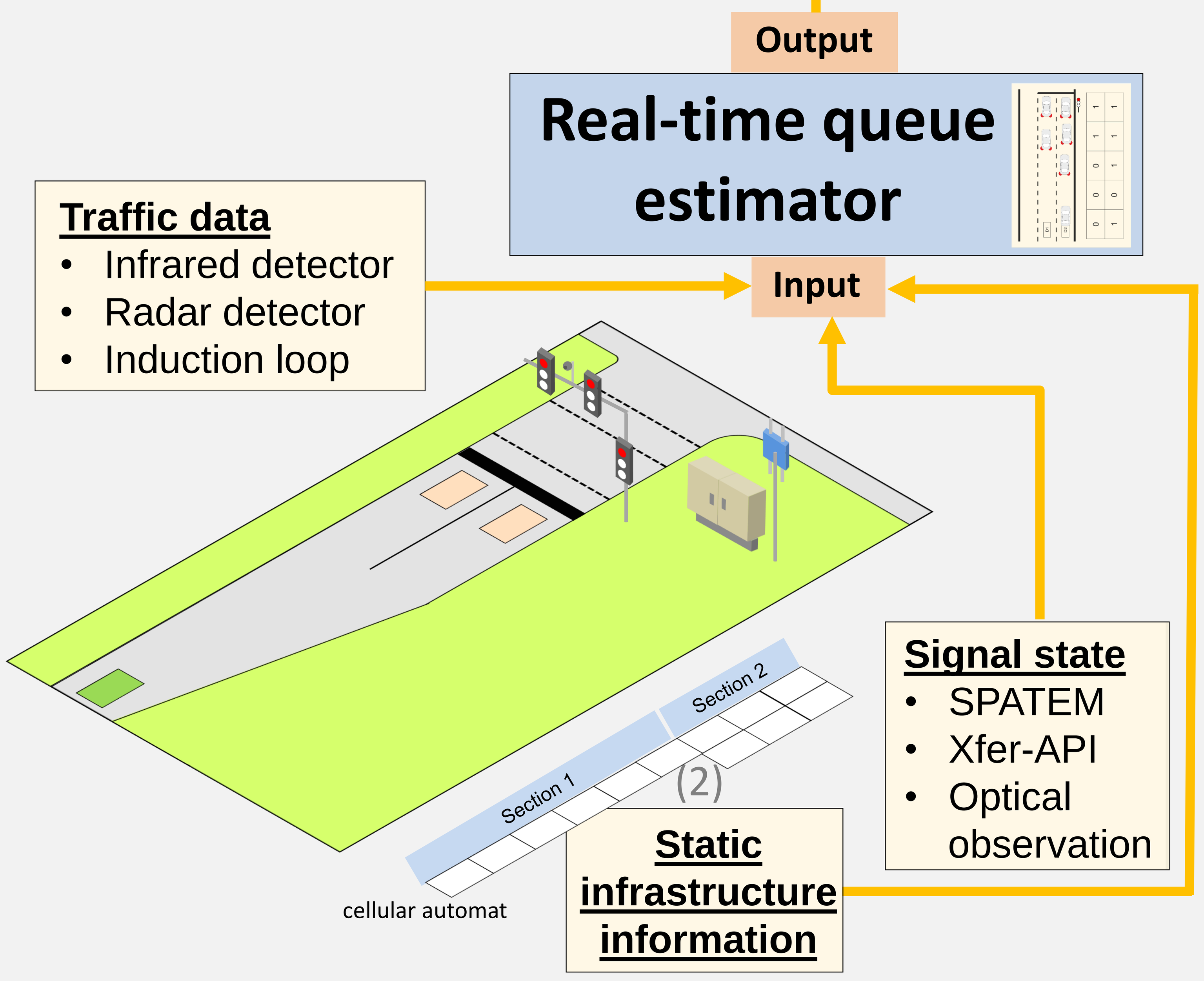
Function

The QE contains a simple traffic model based on a cellular automat. In these automat, the movements of the vehicles (approaching the junction) are simulated. The figure (1) beneath shows a example for queue estimators cellular automat of a two lane approach at a signalised intersection. For each detector count a vehicle is inserted into the cellular automat. The cellular automat simulates the movements of the vehicles in the approach. Vehicles are removed (if green light) or added to a virtual queue (if red light or the queue has not yet been removed).



0	0	0	1	1
1	0	1	1	1

To be able to map different infrastructure conditions, sections must be defined. A section represent in the cellular automat a road with same condition (one lane/ two lanes). The sections are linked to each other, so that the QE can determine the queue length for more complex approaches. "Linked" means that all sections together form the QEs cellular automat (2). By using several QEs in one approach, the queue length of a road with lanes signalised by different signal groups could be determined (3). Its enables to estimate the queue length lane precisely.

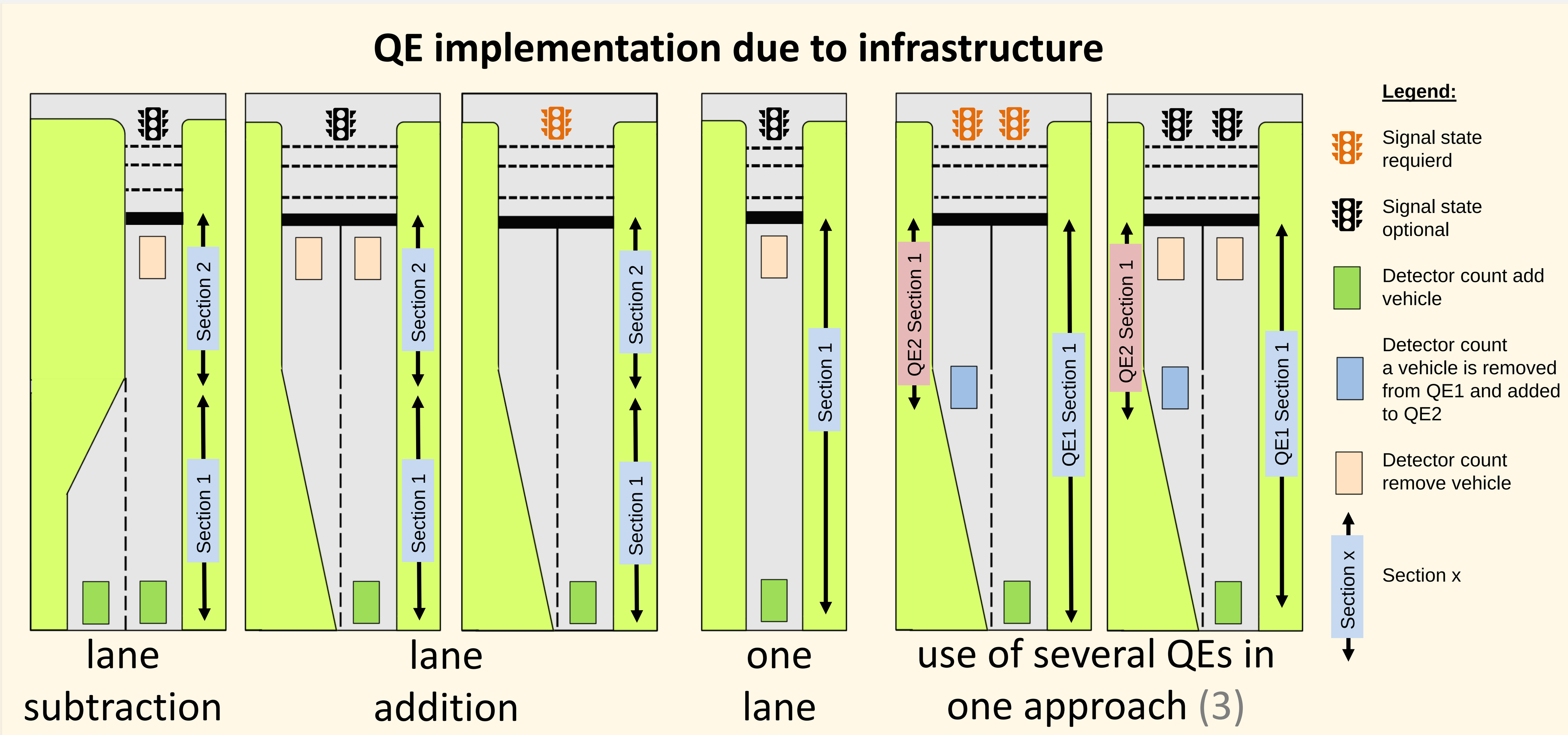


The QE is initially configured with **static infrastructure information** of the intersection. Than the QE is continuously fed with **real-time data.** After a short settling phase (approx. 2 to 3 cycles of the traffic light) the QE provide **QE estimation data** of an approach. The QE estimation data could be used for different **services**.

Static infrastructure information (input)
- distance between a detector (detection point) and the stop line or distance between detectors (detection points)
- number of lanes (for each section)
- maximal allowed speed
- necessary green time per vehicle

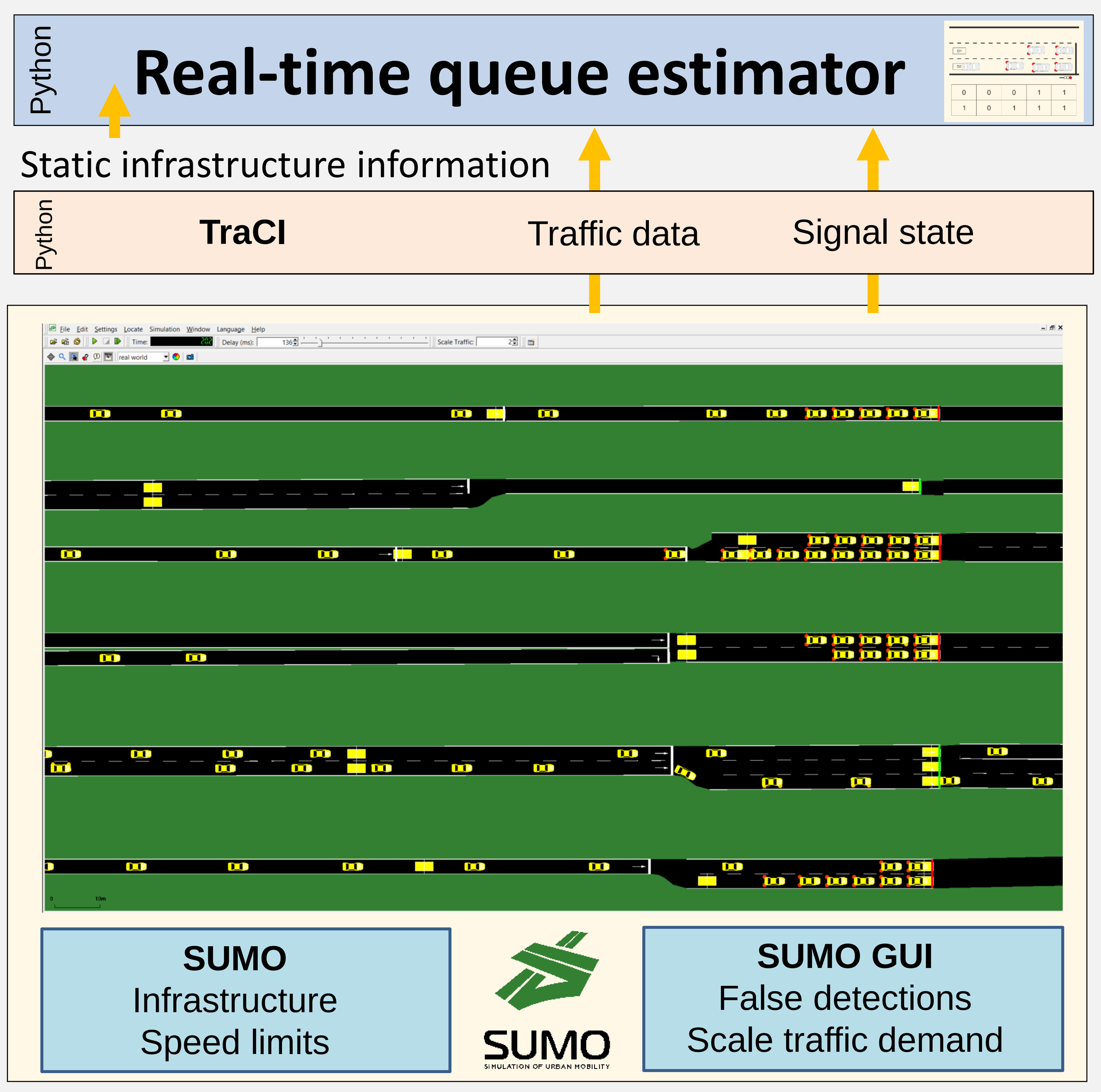
Real-time data (input):
- point-based vehicle counts (traffic data)
- current signal state

QE estimation data of an approach (output):
- total number of queued vehicles (overall vehicles)
- queue length in meters
- queue length in vehicles
- theoretical maximum number of vehicles has been reached (the position of the most distant detector has been reached)



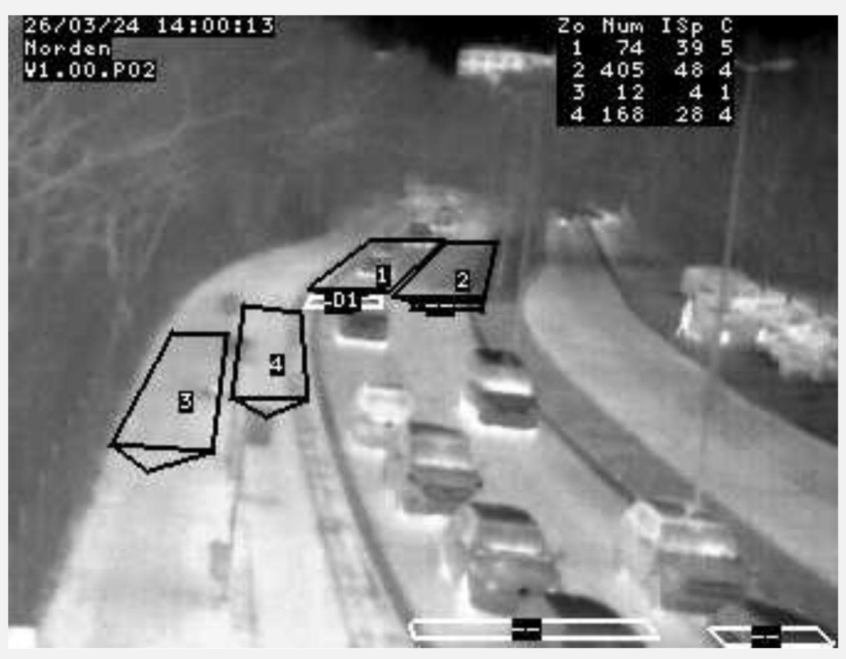
Sumo test environment

The concept of QE is developed in python code and prototypically tested with Traffic Control Interface (TraCI) in conjunction with a SUMO-simulation. SUMO served as a source of input data for the detector data and signal state and offers the possibility of validation through the SUMO-GUI. It is possible to map different infrastructure conditions, such lane addition or lane subtraction and the different availability as well as position of detectors and whether a traffic light state is available plus such as different traffic demands. False detections (no detection or double detection) of vehicles could also be caused in the SUMO-simulation and thus mechanisms could be implemented and tested to correct/intercept these.



Outlook and Future Work

In a next step, the QE will be tested at a real intersection with real input data. The picture beneath shows a detection frame of an infrared detector from the research intersection Tostmannplatz in Braunschweig. It shows the potential to define and use different detection areas. With combination of the infrared detector count data and the actual signal state via Xfer-API the QE will be tested with real data.



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