Study of traffic management strategies in the Zürich area

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Zurich streets among Europe’s most congested

by Matthew Allen in Zurich, swissinfo.ch

Zurich car drivers spend more time stuck in traffic jams than in most other European cities, but the city is unrepentant about its pedestrian friendly policy.

A recent survey has revealed that more than a quarter of roads in Switzerland’s main business conglomeration are clogged, putting Zurich in 16th place in the list of most congested cities.

The survey by Dutch navigation system maker TomTom comes days after a critical report in the New York Times accusing Zurich of “working overtime in recent years to torment drivers”.

The article reports that traffic lights are programmed to favour trams while pedestrian crossings have been moved from underground passages to street level.

The TomTom analysis found that daytime traffic on 27.4 per cent of Zurich city’s streets was forced to travel less than 70 per cent as fast as during the night when roads are less busy. Brussels came out worst in the report with nearly 40 per cent of its streets congested.

Everyone needs to learn to share the streets (Keystone)
Why cities are often congested?

Because the capacity of the street network is not able to cope with all the traffic demand

• Cities concentrate **many activities** in a small area
• **Commuters**, typically, create the biggest traffic problems
• Normally, the worst scenarios happen on working days in the **morning** and in the **evening peaks**
• Traffic congestion has a huge **impact on the quality of living** in cities
• How can we **address** this situation?
  – Better and more rational planning of cities and transport systems
  – Promotion of more sustainable transport modes
  – Pricing strategies
  – **More efficient operations**

MACROSCOPIC CONTROL OF CITIES
The city of Zürich employs an innovative traffic access control system

The adaptive control system works in the following way:

- Measurement of the *level of service* (LOS) in certain links in the city
- Detection of a LOS change
- Modification of *traffic signal control* in the roads accessing the city

- This system represents a clear step towards more **efficient urban operations**
- However, since 2007 **has not been upgraded**
- A more tailored and **dynamic system** could be implemented

Source: Stadt Zürich, Dienstabteilung Verkehr. Presentation by Christian Heimgartner (2009)
Does it make sense to control the number of cars in a city? What does the research say?

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<td>These models were more focused on the uncongested branch of the diagram... <strong>but what happens when we reach congestion?</strong></td>
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The Macroscopic Fundamental Diagram (MFD) is an operational scheme for network capacity control.

- Certain city areas have a relationship between the accumulation of vehicles and the number of trips ended, following a Macroscopic Fundamental Diagram (MFD).

- That allows to know (through monitoring) how the urban area is performing.

- If the perimeter of this area is controlled, the system can be moved to more uncongested scenarios.

- In contrast to ZüriTraffic, the MFD continuously assesses the traffic states within the city and can adapt easily to the capacity and traffic requirements.

Source: Carlos F. Daganzo, UCB
How do we create a MFD for Zürich?

The **trip production rate** in the network is proportional to the **weighted flows** measured in the loop detectors:

**YOKOHAMA EXPERIMENT:**

(Geroliminis and Daganzo, 2008)

- For every time slice $\Delta t$ (e.g. 5 min)
- Collect flow and density for every loop detector
- Average these values for all loop detectors
- MFD

- The Traffic Engineering group is working with a **VISSIM simulation** of the Zürich inner city
- We have used that model to create **different evening demand scenarios** to build the MFD
- To ensure the existence of a well defined MFD the **city must fulfill certain conditions** of homogeneity
Is it possible to create a MFD for Zürich?
We have used a VISSIM simulation for that

- VISSIM simulates traffic in the inner city of Zürich
- The demand data correspond to the 5-6 pm period on a working day
- All the transport modes interact in the simulation but the counts refer to:
  - cars, vans, trucks and buses
- We store the flow and density of every link in the network for every 5 minutes period
- In order to cover the whole MFD we have considered 17 demand scenarios proportional to the original OD matrix
- Every simulation has been repeated 4 times with different random seeds
- In total, 68 one hour simulations have been carried out
The MFD for the inner city of Zürich from VISSIM:

\[ q_{\downarrow W} = \frac{\sum_{i} q_{\downarrow} \cdot l_{i}}{\sum_{i} l_{i}} \quad k_{\downarrow W} = \frac{\sum_{i} k_{\downarrow} \cdot l_{i}}{\sum_{i} l_{i}} \]

- \( q_{\downarrow W} \): weighted flows (veh/h)
- \( k_{\downarrow W} \): weighted density (veh/km)
- \( q_{i} \): flow of the link \( i \)
- \( k_{i} \): density of the link \( i \)
- \( l_{i} \): length of the link \( i \)
The MFD for the inner city of Zürich from VISSIM:

$q_{down} = \frac{\sum_{i} q_{i} \cdot l_{i}}{\sum_{i} l_{i}} \quad k_{down} = \frac{\sum_{i} k_{i} \cdot l_{i}}{\sum_{i} l_{i}}$

$q_{i}$: flow of the link $i$
$k_{i}$: density of the link $i$
$l_{i}$: length of the link $i$
Which factors have influenced the shape, size, and accuracy of this MFD?

- Non realistic links
- Resolution
- Random seed
- Warm-up time
- VISSIM calibration
- Fixed traffic light scheme
- Demand factors
The MFD presents some scattering in the congested part

- We consider **different demand factors** (e.g. times 3) but keeping the **same route choice** model
- **Increasing the demand** also increases the **disappearance** rate of the system
- The **congestion propagation** has clear effects on the **heterogeneity** of traffic states

Mazloumian, Geroliminis and Helbing (2009) analyzed the effect that the variability of the congestion spread has on the MFD
How can a MFD with real data be obtained?

Obtaining the MFD from the microsimulation model presents certain inaccuracies, which could be avoided with real data.

• The real data needed to obtain a consistent MFD is provided by traffic measures at loop detectors

• It is necessary that the loop detector network is dense and homogeneous enough so all the network is measured

• The city of Zürich has 3500 loop detectors, a rather large number for a city of its size
How many detectors would be necessary?

- VISSIM considers 1707 links to build the MFD
- We have chosen 6 different combinations of 25, 50, 75, 100, 125, 150, 175, 200, 225, and 250 random links...
- ...To see how a MFD created with a limited number of detectors could look compared to the one obtained monitoring all links

- With less than 150 links the variability might be considerable
How can we use the MFD?

A Macroscopic perimeter control is a flexible and responsive mechanism to ensure a certain congestion state in the city.

Let's compare it to the adaptive control system!

Source: Nikolas Geroliminis, EPFL
We have chosen 2 of the links that are measured by Züritraffic, and we plot their individual fundamental diagrams with the VISSIM simulation data:

- The two links present different shapes and reach congestion at different times

The MFD, in contrast to the Züritraffic, might provide a better global view of the system
What steps the city of Zürich can take towards more efficient traffic management?

- The city of Zürich has 3500 loop detectors, a rather large number for a city of its size.
- The monitoring scheme needs very efficient IT systems to bring and process the information at real time.
- With a better data gathering and more focus on the analysis of these data, innovative traffic management techniques could be applied (MFD as a ground for the ZüriTraffic).
- That amount of detectors not only is enough for building a MFD, but if the data was efficiently collected, new traffic management techniques and cutting edge research could be carried out.

ZürichLAB
Questions?

Thank you!