Individual Travellers' advice:
System Set-up, Measures, and Expected Results

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Abstract

Traffic congestion can be reduced by traffic control. Individual traffic control gives the largest range of possibilities to control traffic. However, having more possibilities to intervene also raises the question what is the best process to control. This paper explores the possibilities to intervene in the traffic processes and lists the best possibilities to alleviate traffic congestion based on insights from traffic flow theory. It is discussed which measures are best to take in which conditions, taking into account that drivers can be advised on headway, speed or lane. The paper also shows the structure and the elements required to calculate the optimal advice. Finally, the paper shows what are expected to be the best control strategies for a variety of traffic conditions in a qualitative way.

Solutions from literature

Aiming for synchronised flow

1) Aim for similar speeds in all lanes, leading to a better lane distribution and a higher overall flow

Reduce congestion and stop-and-go waves

2) Avoid lane changes in too small gaps, which lead to stop and go waves
3) Before a lane change, adapt gradually speed of new follower to low speed of lane changer
4) Restrict lane changing in a short section to locally improve capacity
5) Adapt speed of lane changing vehicle before performing lane change
6) Aim for similar speeds in all lanes, leading to less disturbing lane changes and smaller critical gaps for those driver who change lanes
7) Reduce speed when there is a high probability of emerging stop-and-go waves
8) Solve stop-and-go waves by reducing the inflow, in turn realised by reducing the upstream speed

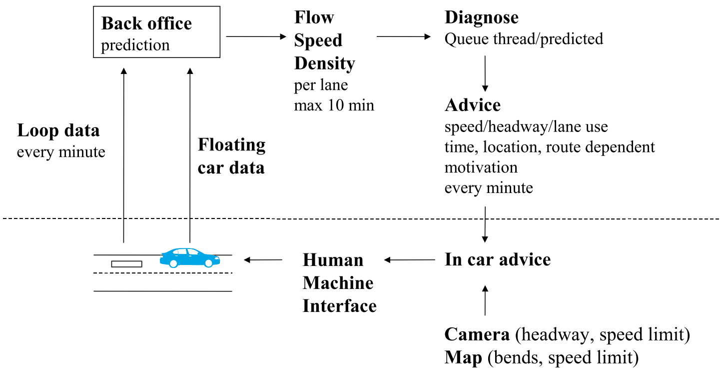
Reducing spillback effects

9) Lane advice to keep congestion to a freeway exit at some lanes, whereas drivers to other destinations can pass

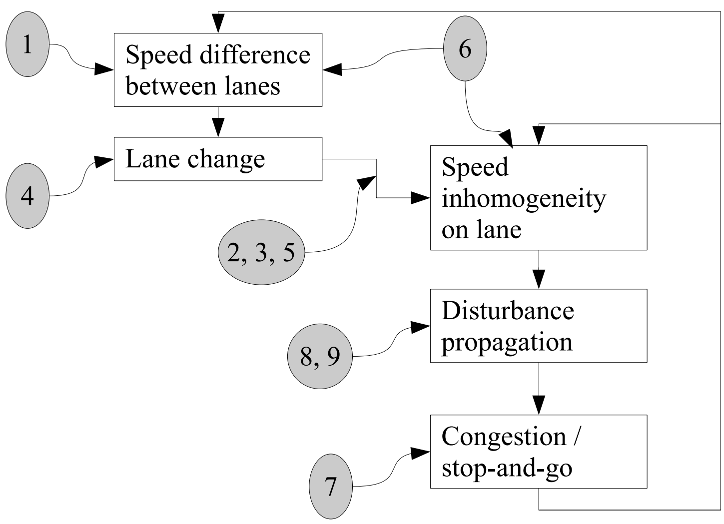
Connected Cruise Control

- In-car lane, speed and headway advice
- Optimize flow, reduce congestion
- Applicable in current road system and vehicles
- Additional individual benefits for the users

Framework



- V2I communication
- In-car advice based on *predicted* downstream condition
- Motivation to inform and motivate drivers
- Advice from back office may be overruled by constraints from in-car measurements



The traffic processes and where the proposed solutions (left) interfere in the traffic processes

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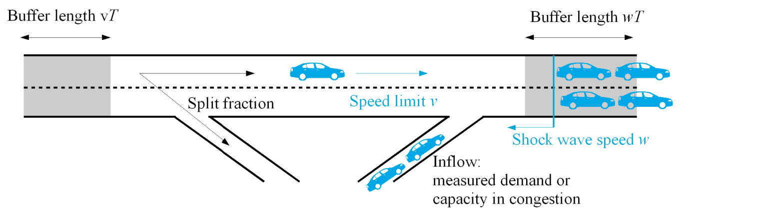
Traffic state prediction

- Lane specific marcroscopic model is used (extension of LWR cell transmission model)
- Short-term prediction of demand and outflow restriction. See figure for possible solutions.
- Propagation of shockwaves correctly predicted for the short term (< 10 minutes)

Requirements for good prediction



1. **Simulate larger network than network of interest (simulated time T): Input link: at least vT extra length; output link: at least wT extra length**
2. **Keep track of the split fraction at junctions**
3. **Simulate measured demand on on-ramps, or capacity in case of congestion**

Expected Results

Situation	Lane advice	Speed advice	Headway advice
(Near) saturated conditions	**Lane advice can avoid disturbances inducing a stop-and-go wave; advice towards lanes with lower densities if possible**	**More homogeneous flow, resulting in less stop-and-go waves and less impact of lane chaning. Risk: congestion due to lower capacity**	**Manage gaps on an individual basis to smoothen lane changing or merging**
Bottleneck	**-**	**-**	**Normally: capacity drop. Headway advice might alert drivers, leading to a smaller headways and a higher capacity**
Stop & Go Waves	**In case of uneven lane distribution, the capacity of the underutilised lanes can be used to solve the stop-and-go wave**	**Reduced inflow due to lower speed, so stop-and-go wave dissolves**	**Stop-and-go wave can be solved by reducing inflow (increasing headway) upstream, or by increasing outflow (awareness increase at the head)**

Conclusions

A system for in-car individual driver advice is studied. The advice consist of a central advice from the road authority, which is merged in-car with restrictions based on the car-sensors.
Individual travellers advice can influence the traffic in many ways, which are listed in the paper. A multi-lane traffic simulation program is developed to test the effects of all measures, accounting for possible conflicting advices from the car. An on-line implementation of this program will help choosing the best general advice.

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