

Traffic dynamics: complex systems, clever solutions

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Relevance

- Cost of traffic jams: €3,400 mln/jr
- Cause: traffic demand exceeds capacity
- Traffic works well up to capacity, but for higher demand, self-organisation is quite bad....



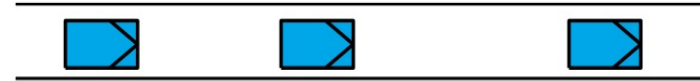
*A lack of passion can do
more harm than
simple inexperience:*

Introduction to principles of traffic flow theory

Traffic flow theory: macroscopic view

Scales of traffic description

- Microscopic: individual level



- Macroscopic: road level



- Higher level: network level



Car-following models

- Correct simulation tools:
- Predictions for unknown roads
- Driver assistance systems,
e.g. Adaptive Cruise Control (ACC),
ultimately autonomous vehicles
 - What feels most natural?
 - What impact does it have

Car-following models: two components

- Free flow: how do you accelerate to your free-flow speed (and how fast is that)
- Congestion: how do you react to your predecessor?
- Often occurring problem: minimum headways are larger when coming out of congestion

Capacity = $1/(\text{min headway})$

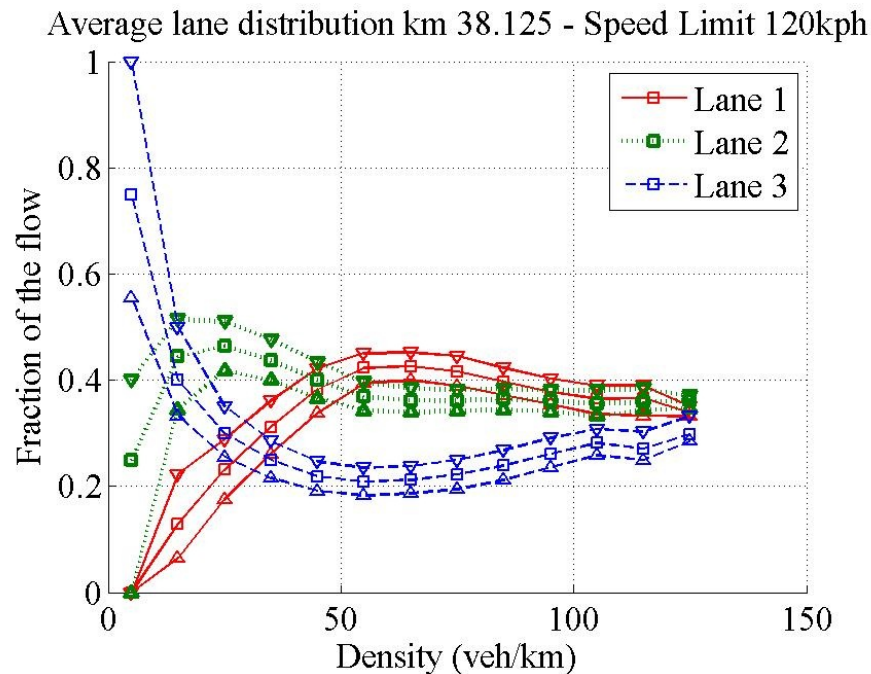
- Traffic jams are upstream of a bottleneck:



- Capacity is determined by the minimum headway when driving out of the queue
- Larger headways = lower capacity => **capacity drop due to queue**

Lane-changing

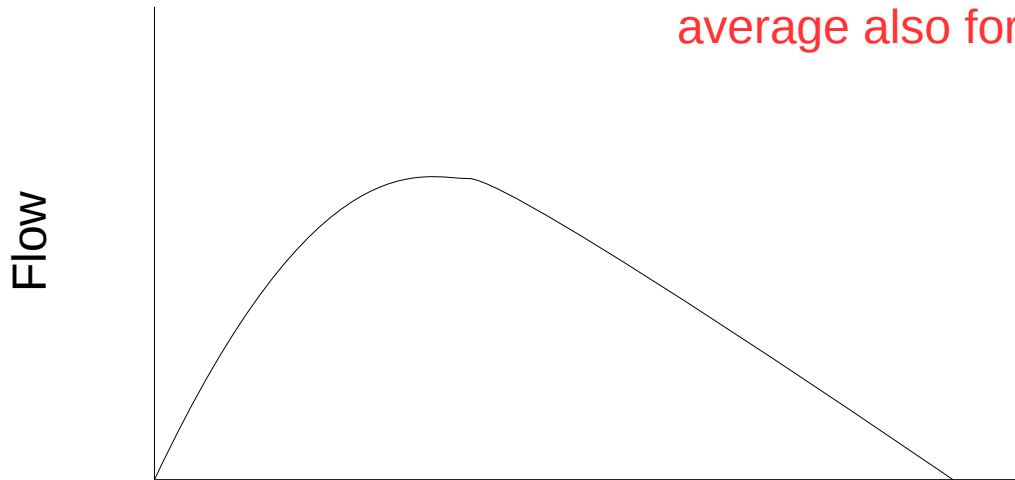
- When traffic gets busier, more people take the left lane
- Right lane under-utilized



Traffic flow theory: macroscopic view

Relationships variables

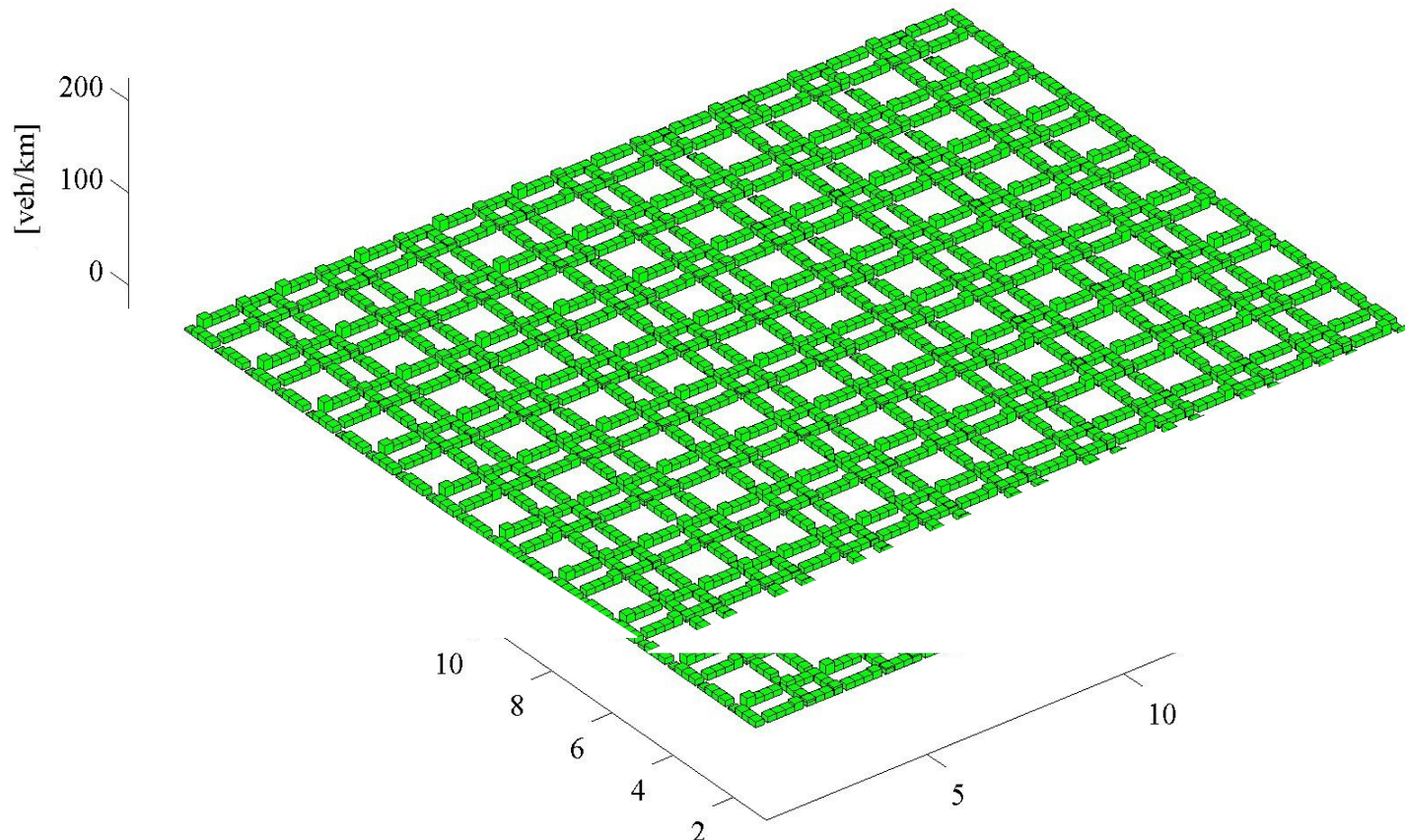
Holds for a road, but on average also for a zone!

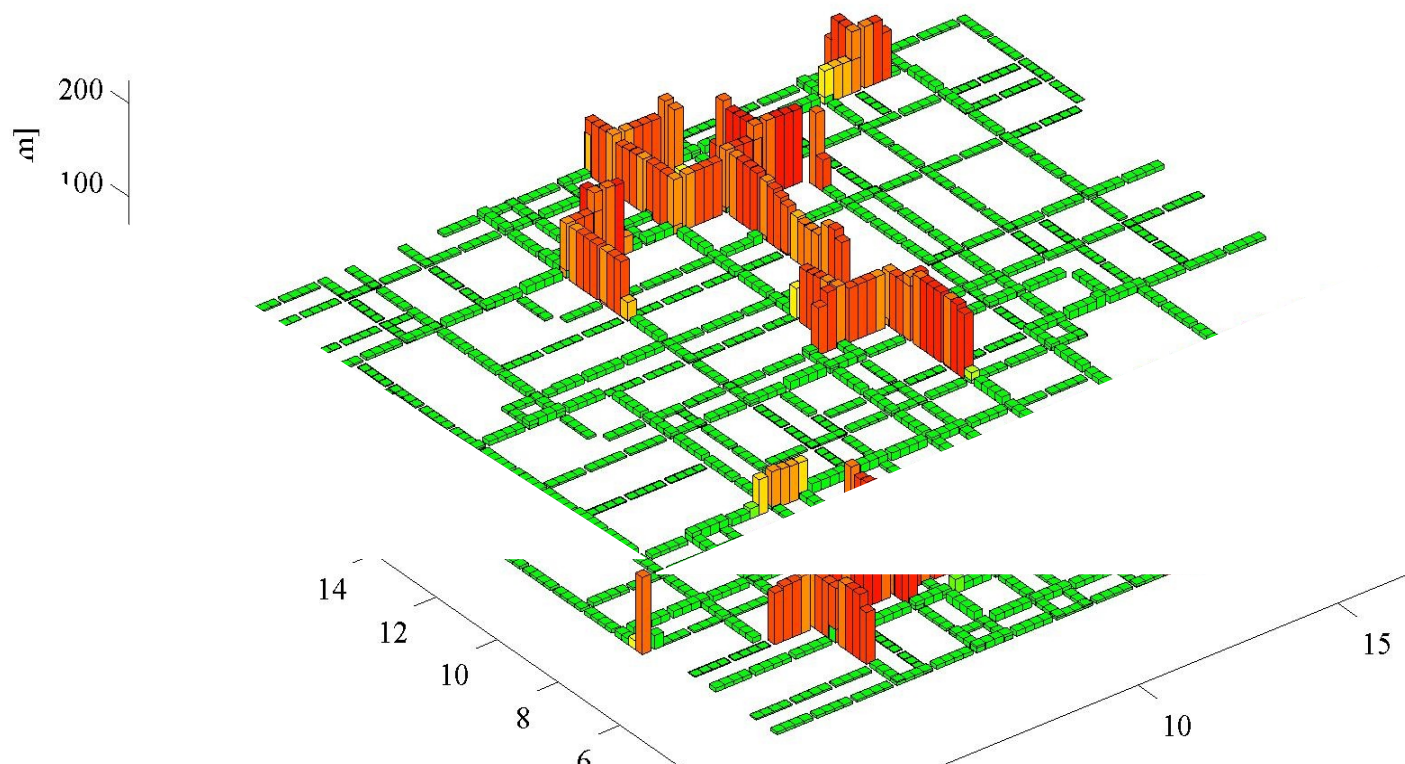


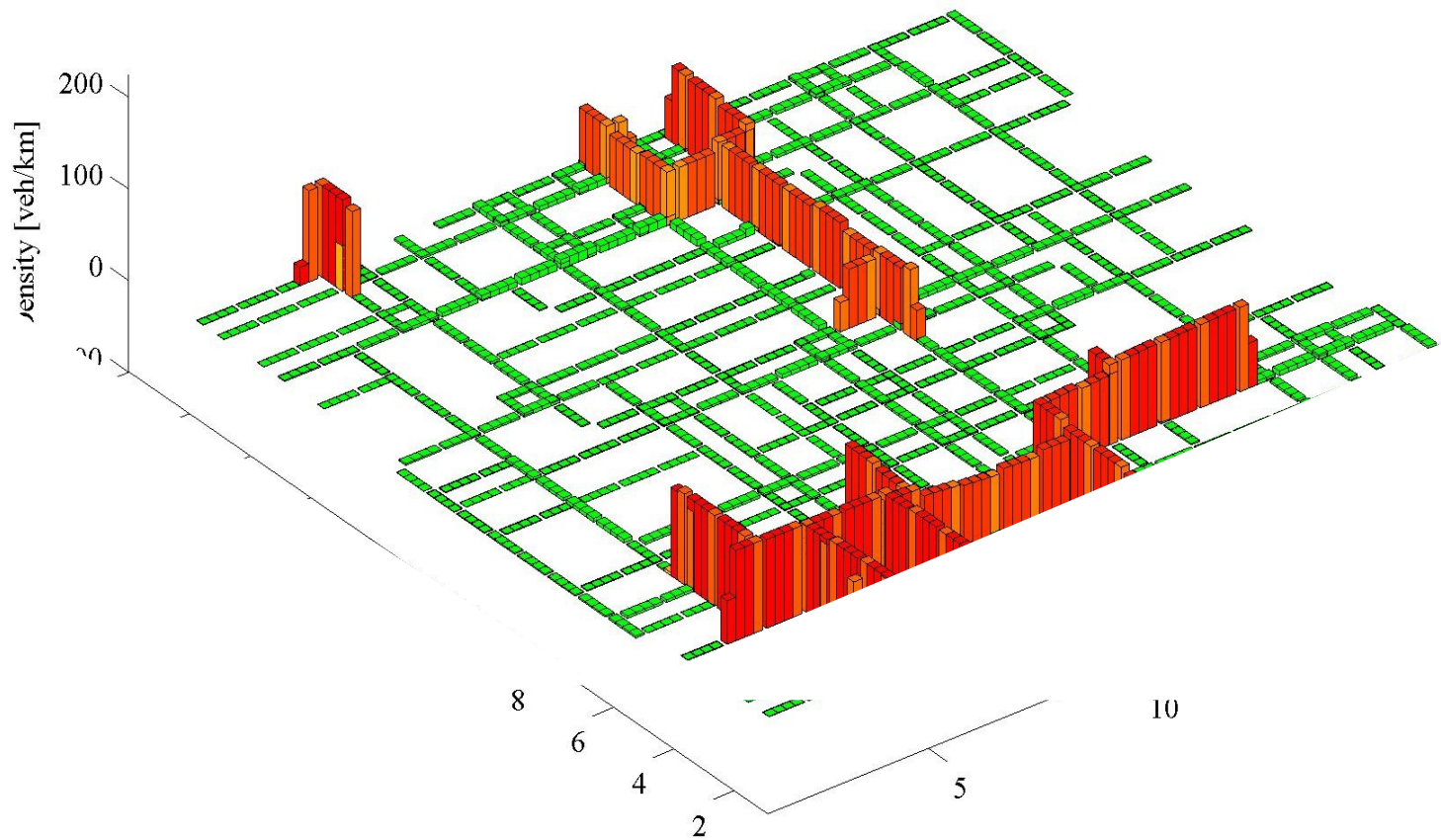
Density



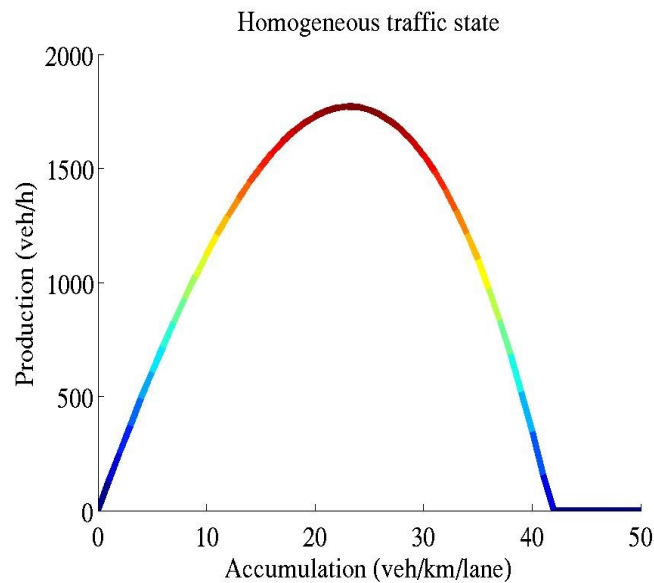
Build up of congestion



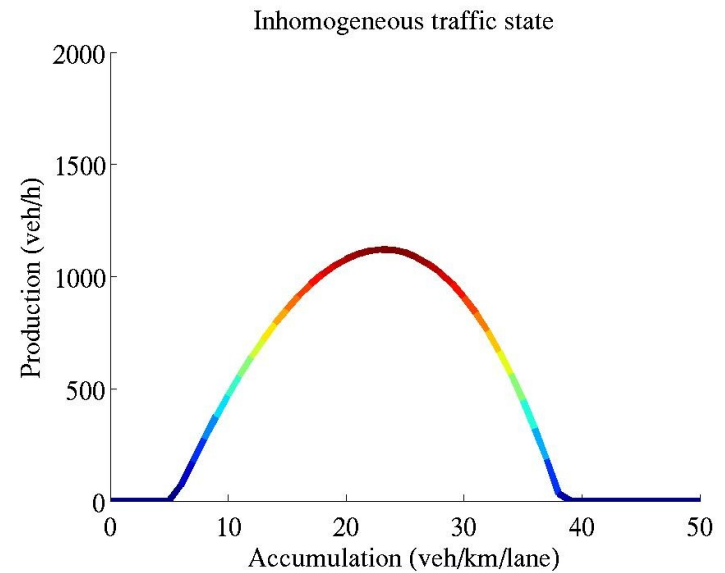




Fitting a functional form



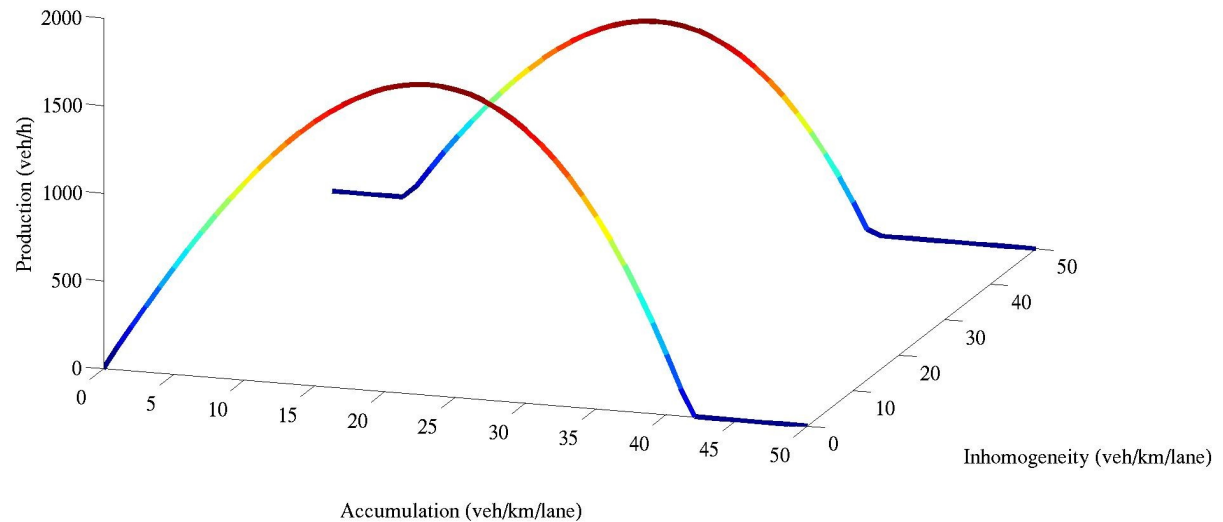
Homogeneous traffic situation



Inhomogeneous traffic situation

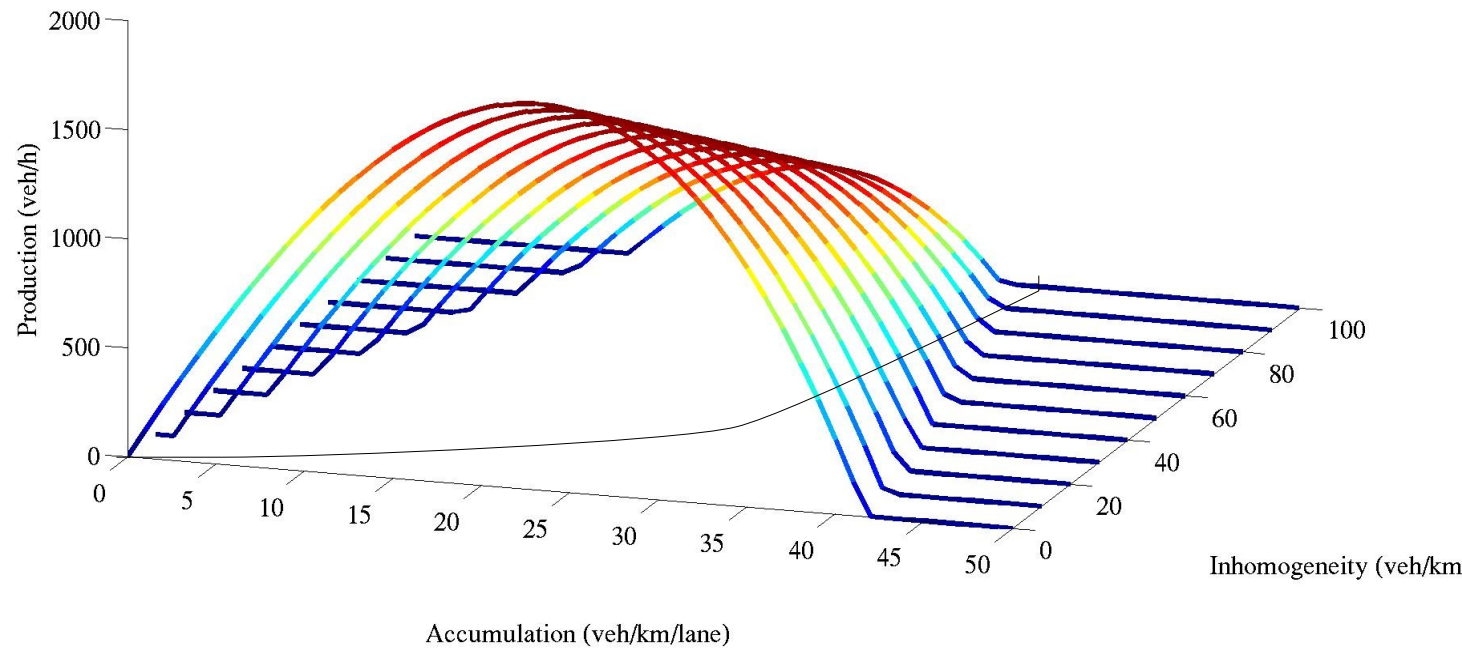
Fitting a functional form

Homogeneous and inhomogeneous conditions

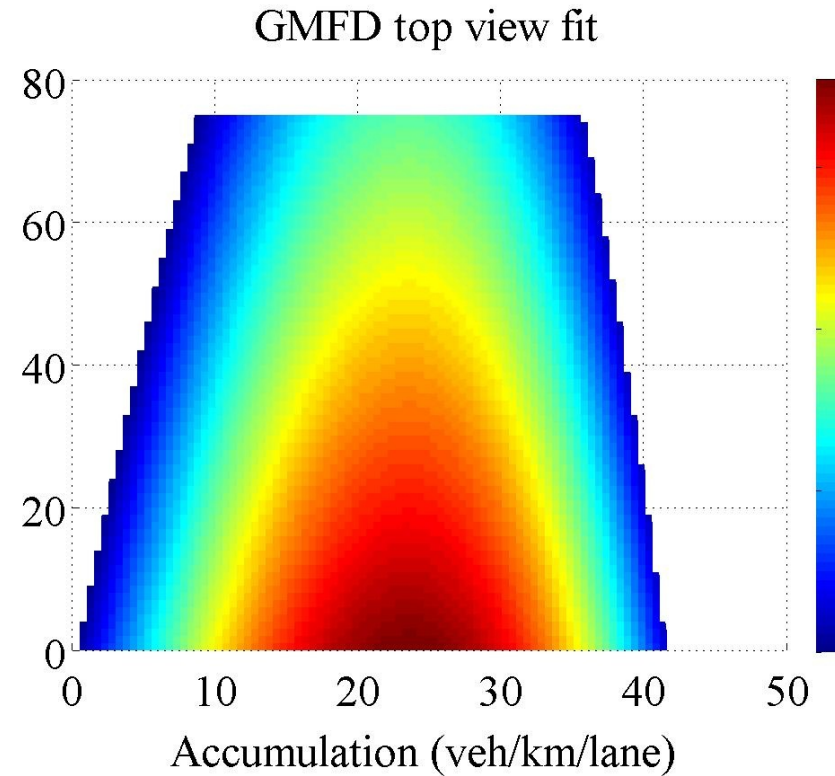


Fitting a functional form

Different traffic conditions



Empirical evidence



Suitable for any queuing application?



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How about the
Centre for Complex Systems Studies?



Challenges

- 1) Incidents
 - => detection?
 - => prevention?
- 2) Use of automated vehicles
 - => vehicle operations?
 - => network use?
- 3) Balancing space for target lanes (microscopic, macroscopic)
 - => Multi-lane traffic (dynamically?)
 - => Multi-class traffic?
- 4) Network control
 - => Global optimum of traffic lights?
 - => Agent-systems?
- 5) Non-vehicular modes:
 - => How to influence active-mode users (pedestrians, cyclists?)
 - => combine with public transport
(scheduling, interactions with car traffic (desired?))