Two-Variable Macropscopic Fundamental Diagrams for Traffic Networks

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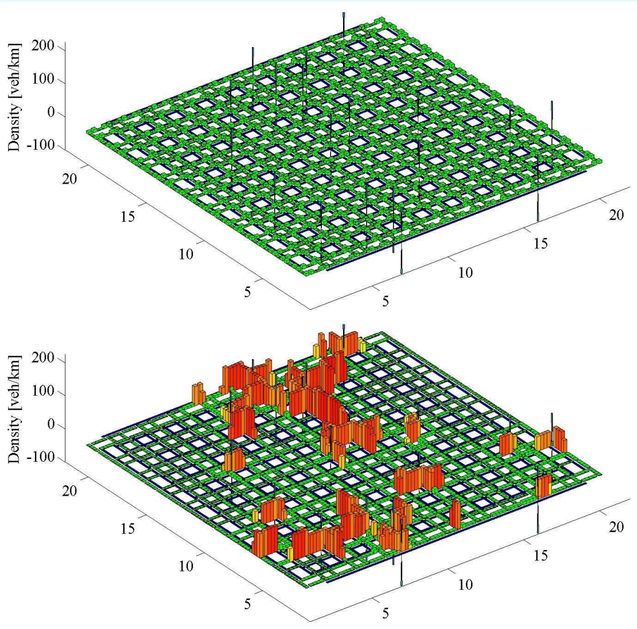
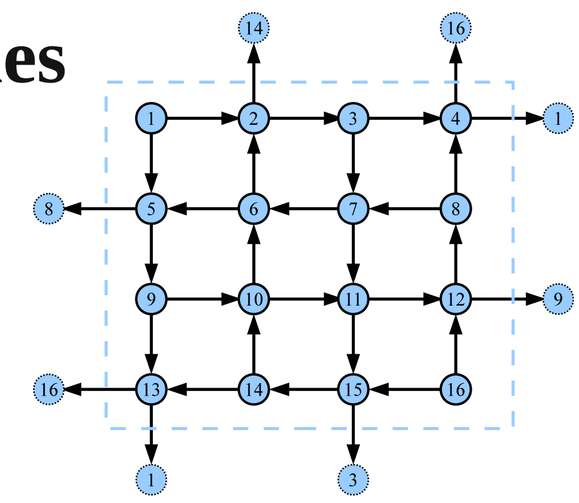
Abstract

The macroscopic fundamental diagram (MFD) relates the traffic production (average flow) in an area to the accumulation (average density), under the assumption of homogeneous traffic conditions. In real life, this assumption is not met. Using simulation we study the impact of inhomogeneous traffic conditions on the MFD, using a regular grid network. Due to inhomogeneous origins and destinations, traffic congestion occurs at some locations in the network. It is found that a two-dimensional MFD holds. The *production* can be related to the *accumulation* and the *spatial spread of the density* over the network, expressed as the standard deviation of the densities at each location. This also holds for the performance (arrival rate).



Grid network with periodic boundaries

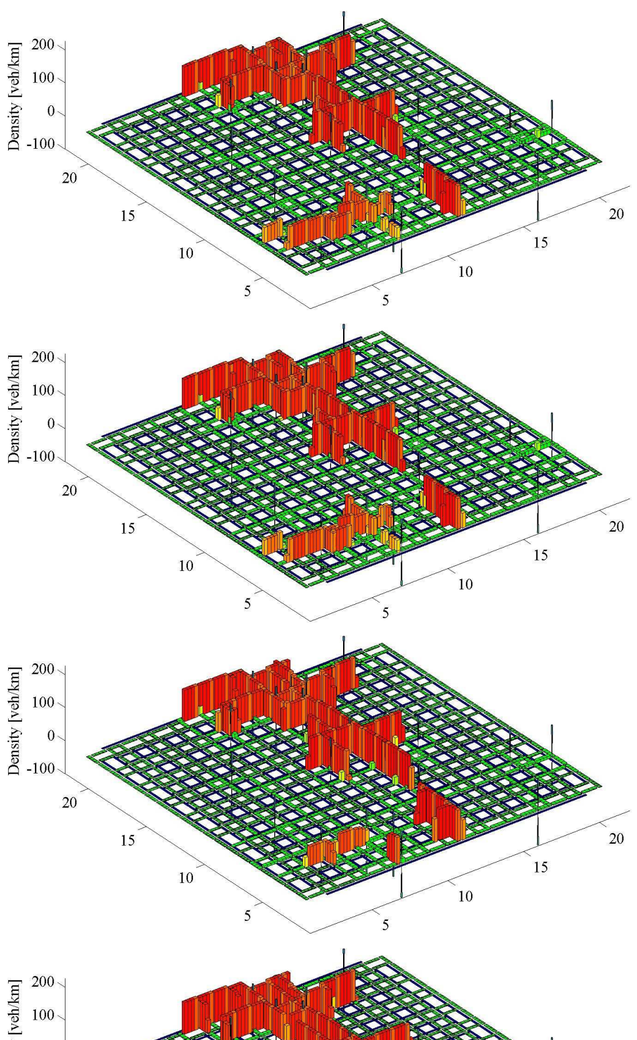
- 20 x 20 Manhattan grid network
- Periodic boundaries, 2 links per node
- 19 random destinations
- 1st order macroscopic traffic flow model (LWR)
- Capacity restriction on node, no flow interruptions
- Redestination upon arrival => nr of vehicles constant



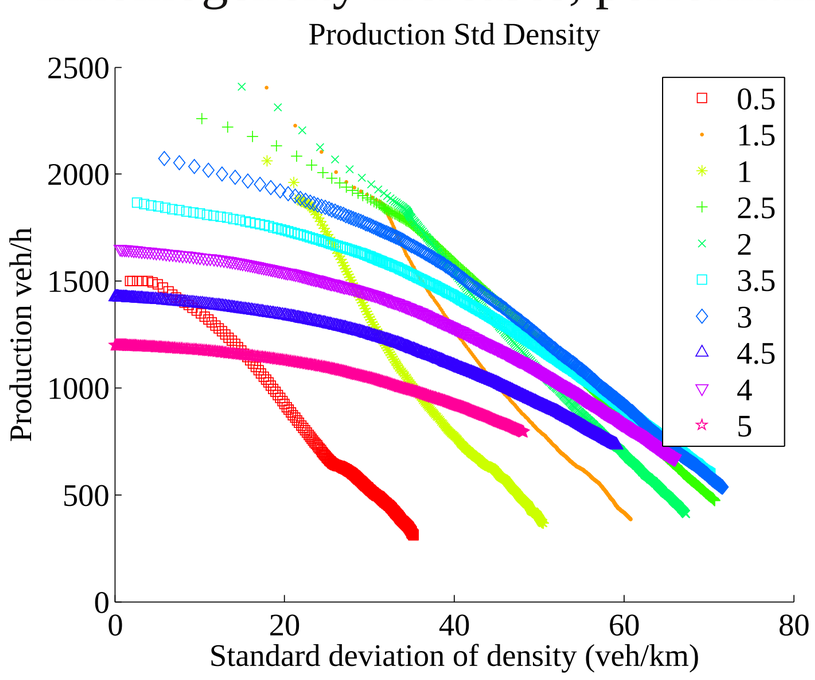
Example of periodic boundaries at a 4x4 network

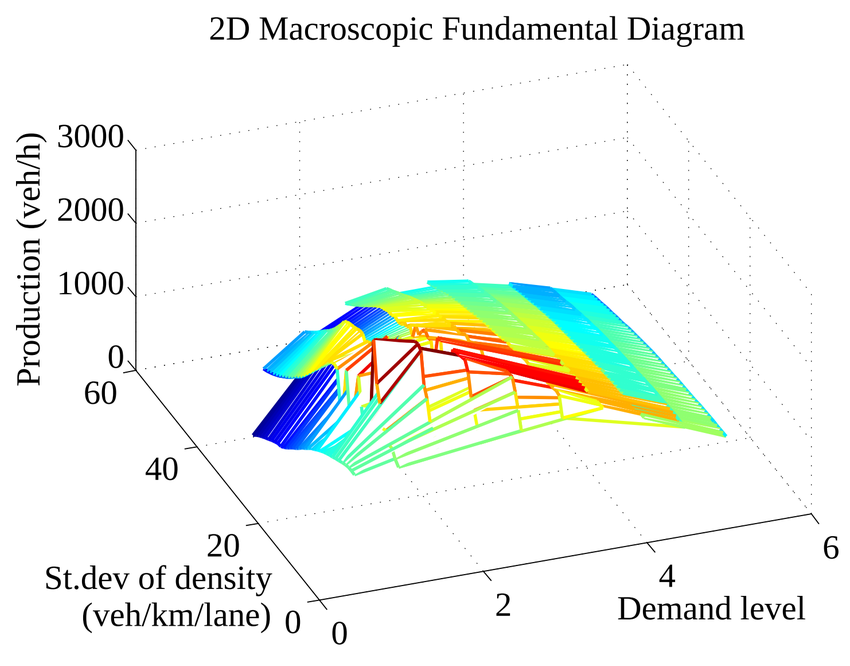
Congestion build-up

- Traffic is initially distributed equally
- Near bottlenecks, it slows down
- This creates more congestion (*nucleation points*)
- Inhomogeneity increases, performance decreases



Evolution of the network densities en speed





Two-dimensional fundamental diagram

- A continuous two-dimensional fundamental diagram exists
- Production is convex in the accumulation
  (similar to normal fundamental diagram and MFD)
- Decreasing with the spatial spread of density
  (expressed in the standard deviation of densities of all cells)
- New possibilities for real-time control, using less data

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