

## Traffic Management by Macroscopic Models

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Macroscopic traffic flow models have become popular in transportation engineering and applied mathematics during the last decades. These models give a description of collective dynamics in terms of spatial density and average velocity, which evolve according to partial differential equations derived from fluid dynamics, coupled with suitable closure relations. In fact, even if the *continuum hypothesis* is clearly not physically satisfied, macroscopic quantities can be regarded as measures of traffic conditions and allow depicting the spatio-temporal evolution of traffic waves. Moreover, they are suitable for analytical investigations and very efficient from the numerical point of view. Therefore, they provide the right framework to state and solve control and optimization problems for real time applications.

Starting from the celebrated Lighthill-Whitham-Richards model formulated in the mid 50ties, mathematicians and engineers designed various more sophisticated models in order to capture specific traffic characteristics. These include second order, phase-transition and non-local models. In the case of vehicular traffic, extensions to road networks have been addressed by providing suitable models describing the dynamics at junctions. These improved models are expected to better match observations based on real data coming from different sources: besides the traditional magnetic loop detectors, the recent technological developments provide data extracted from video recording, GPS, Bluetooth, RFID, etc. Indeed, the enormous amount of information available nowadays may suggest that models have become useless! For example, common traffic monitoring and forecast services currently deployed are based on purely statistical data analysis and show good performances, except in case of unexpected events.

Yet, the scope of my talk is to convince you of the interest of developing and using macroscopic models for traffic management. Indeed, macroscopic models and related optimization strategies have shown effective for management and planning purposes. In this talk, I will briefly review the basis of the macroscopic approach for modeling vehicular traffic and crowd movements, and I will show how these models can be efficiently implemented for traffic flow optimization. In particular, I will focus on traffic control strategies based on ramp-metering, variable speed limits and partial rerouting. Further control perspectives are offered by the future deployment of autonomous vehicles.