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WHAT YOU ARE,TAKES YOU FAR

XXXIV Cycle

Large-scale mobility simulation for connected vehicle applications

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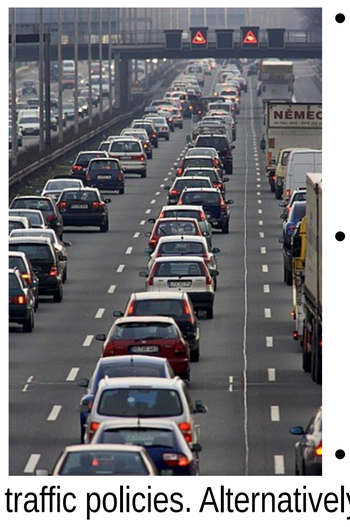
Research context and motivation



- **Simulation tools**, thanks to the continuous progress in this field, are now capable of analyzing increasingly larger areas. **Urban mobility models** can produce a multitude of qualitative and quantitative information regarding traffic behavior.
- Those models are extremely important for Intelligent Transport System (ITS) applications, emerging vehicular technologies, solutions for Smart Cities, analysis of current mobility patterns or traffic emission models.
- Simulations can also be **predictive** for the evaluation of new traffic policies. Alternatively, they can be used in order to inspect how a particular vehicular category (e.g., **car sharing fleets**, **connected cars** or **electric vehicles**) blends in city traffic and how it relates to the resources the urban environment could offer to it.

Addressed research questions/problems

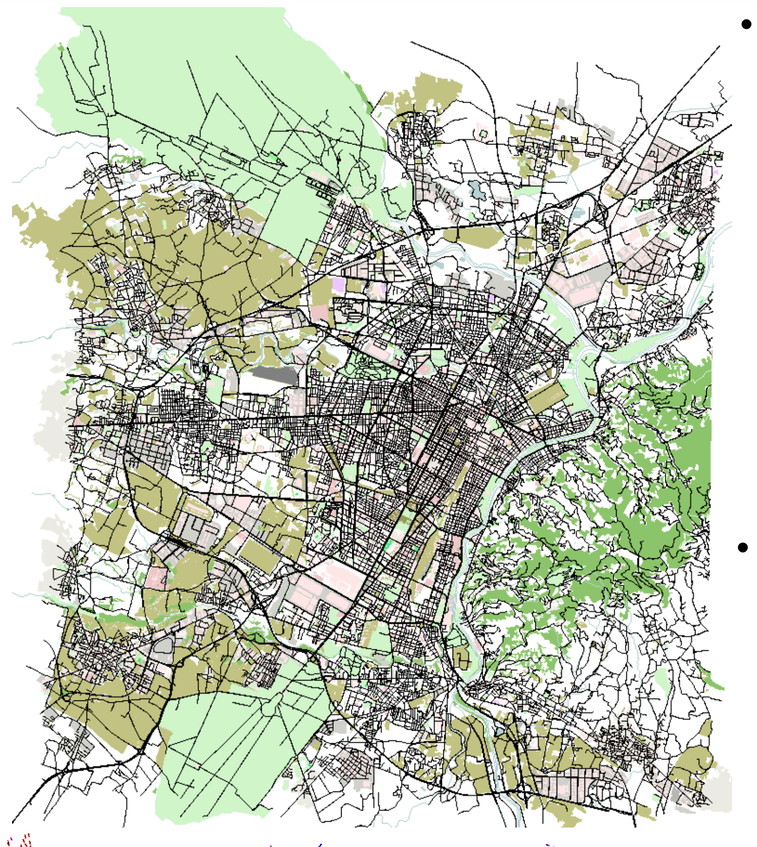
- In **microscopic simulators**, each vehicle is modeled explicitly with its own route and it moves individually through the network. Nevertheless, the complexity of the model grows with the number of vehicles generated in this way, as well as with the size of the area to be analyzed. However, the greater is the investigated area, the more unfeasible would be a test in a real scenario and so the more important it is to use simulations

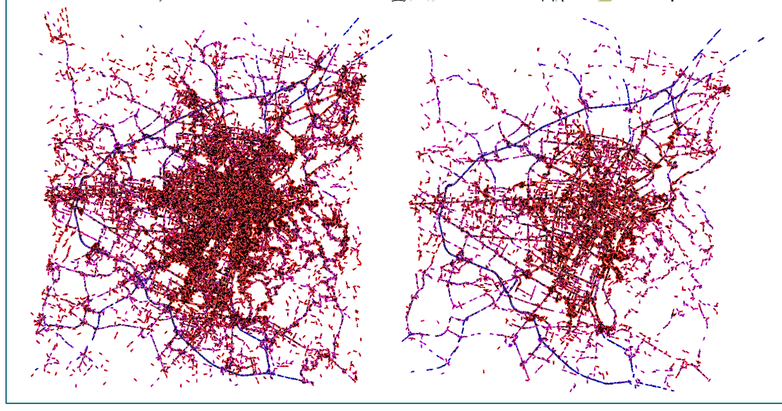
How to build a microscopic and large-scale mobility simulator?

- **SUMO** (Simulator of Urban Mobility) is the state of the art for mobility simulation models. It is a microscopic simulator able to model large-scale networks.

SUMO
SIMULATION OF URBAN MOBILITY

Adopted methodologies

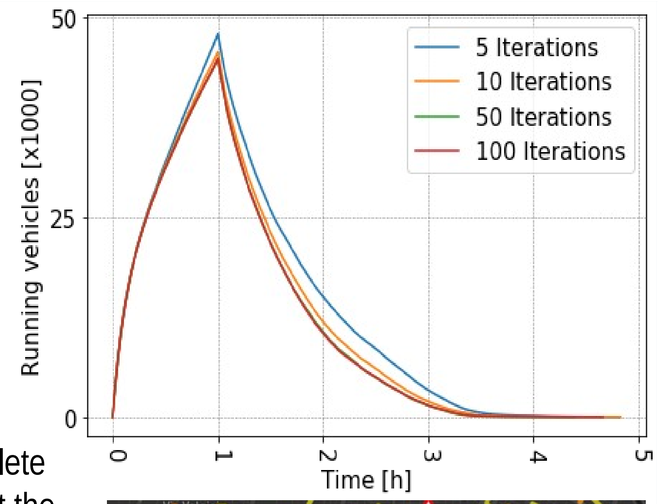


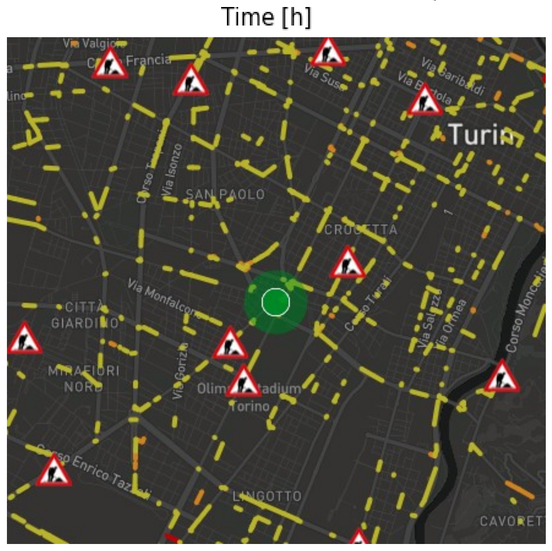


- OSM data were converted in a network file of SUMO-readable XML format, to create the map of the model. Unfortunately the procedure described leads to a network with many errors, so some **manual correction** were needed (average velocities, number of lanes, roundabout connectivity, traffic lights phases and synchronization).
- After **SUMO trips** were created (i.e., to map every car trip into origin edge, destination edge and suitable depart times), a comparison among different **Traffic Assignment algorithms** was performed in order to choose a route that leads the system to a stable situation even in congestion conditions. **Incremental** Traffic Assignment was the algorithm with best performance among the tested ones. Eventually a **Macroscopic Iterative Assignment** method was chosen.

Novel contributions

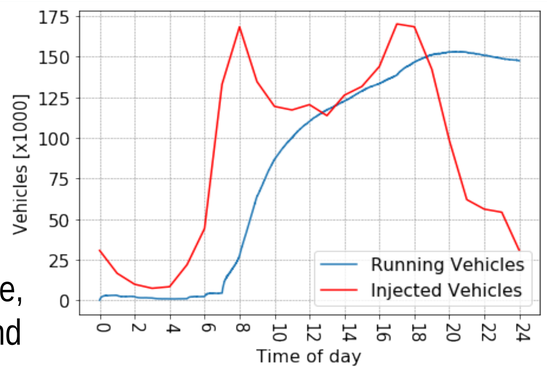
- The dataset provided by **5T** is comprehensive of all vehicle movements in the Province of Turin and constitutes the so-called **Origin/Destination (O/D) matrix**.
- Using the given O/D matrix it is possible to feed the simulator with realistic traffic and to conduct a **stability study** in order to test the goodness of the model. The results obtained demonstrate that a complete modeling of such a wide tool is possible at the expense of minor simplifications.
- Data from simulations can integrate **real-time traffic data** in info-mobility platforms, creating an enhanced Geo-referenced navigation system.
- **Torino Digital Mobility (TDM) platform** is an on-going online project for integrate traffic data from 5T and Geo-positioning from FCA vehicles, using TIM 5G network.

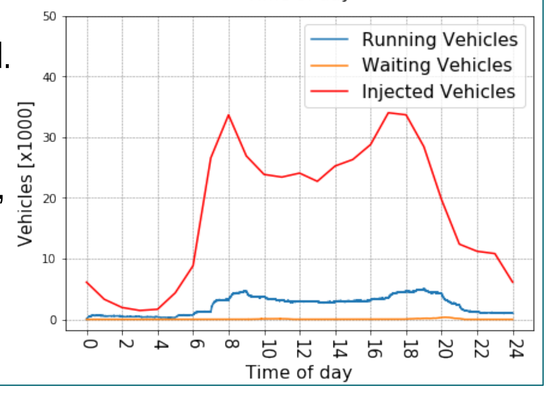




Open problems

- A peak hour of traffic is injected in the model with minor error. When we try to inject a full-day traffic pattern, the number of running vehicles grows enormously.
- This is due to the effect of **waiting vehicles**: vehicles that are scheduled to enter at a given time, but, due to congestion in the origin area, do not find room in the map. This effect is mitigated if simulations of a single hour of traffic are performed.
- A possible way to study the portion of the traffic we can handle at this stage of model development, is to **scale down** the number of vehicles injected. If 20% of daily traffic is introduced in the model, the number of waiting vehicles is negligible.





Future work

- Improvements in the map construction
- Solving the problem of waiting vehicles
- Real-time data insertion from 5T sensors

Submitted and published works

- Avino G., Malinverno M., Casetti C., Chiasserini C. F., Malandrino F., Rapelli M., Zennaro G., "*Support of Safety Services through Vehicular Communications: The Intersection Collision Avoidance Use Case*", Automotive, Milan (Italy), 2018
- Rapelli, M. , Casetti, C., Gagliardi, G., "*TuST: from Raw Data to Vehicular Traffic Simulation in Turin*", 2019 IEEE/ACM 23rd International Symposium on Distributed Simulation and Real Time Applications (DS-RT), Cosenza (Italy), 2019

List of attended classes

- 01QTEIU – Data mining concepts and algorithms (14/12/2018, credits: 4)
- 01QTZRS – Geomatics and gis for environmental application and regional planning (18/1/2019, credits: 6)
- 01SWPRV – Time management (2/7/2019, credits: 1)
- 01QORRV – Writing Scientific Papers in English (28/3/2019, credits: 3)

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