# Towards data-driven models for traffic congestion in urban road-networks

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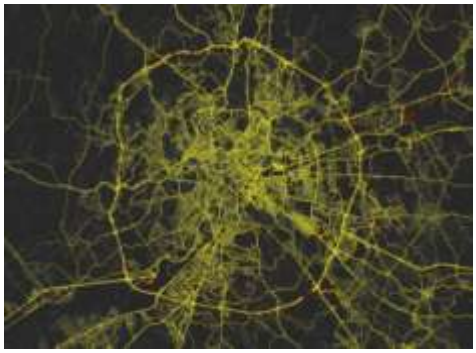
## 1 First Section

Information Communication Technologies (ICT) are now opening the possibility of collecting microscopic dynamical data on large socio-technological systems [1]. This means, for example, that in the next future we shall be able to have real time data on single vehicle position and velocity for a whole urban road network. The data processing and the information extraction is a new challenge for traffic modelling and could define a roadmap toward policies of traffic governance able to optimize the actual road network performance and to prevent, or at least to reduce, the consequence of large scale congestion phenomena. Nowadays Italy is a perfect location to develop new data-driven traffic models based on GPS data from single vehicle. Indeed ~3% of the entire Italian vehicle population is monitored by a GPS system for insurance reasons[2] and each trajectory is sampled with a spatial resolution scale of 2 Km. Despite the spatial low resolution, the possibility of recording long time series (1 month is enough) allows a reconstruction of the trajectory even in a urban road network for the majority of vehicles [3] (we take advantage from the habits in urban mobility). This information can be related to the congestion state of the considered road network[4] using the travel time and the covered distance by individuals during constant short time intervals. Our aim is twofold: from one hand we expect to discover macroscopic observables (control variables) able to give information on the physical state of traffic in the road network[5]; from the other hand we try to detect the cognitive strategies that characterize human mobility from the path choice according to the traffic conditions to the organization of the daily agenda[5,6,7,8]. This analysis requires efficient algorithms able to georeferencing big amount of GPS data on a urban road network of large cities and the building up of microscopic models able to reproduce the both physical and the cognitive aspects of traffic dynamics. As an example, in the following figures we report distribution of the recorded GPS vehicle data in the Rome urban road network (40000 monitored vehicles) for the entire month of May 2010 (left figure) and the traveling velocities on the Torino road network (left picture) in a color scale from red (< 30 Km/h) to blue (> 90 Km/h) .



In this work we discuss some results on the global statistical properties of urban traffic in different Italian cities by using the GPS data to perform a real-time reconstruction of the traffic state across the whole urban network (nowcasting), and we present some simulation results using microscopic traffic models on a urban road network to understand the rising process of the congestion and to predict the future scenarios under different assumptions . This activity enters in a road-map toward a *safe-city* within the FUTURICT project (http://www.futurict.eu/) in order to generate an entire computational framework with respect to the role of failsafe mechanisms which pertain to crises that are generated by problems of mobility.

## References


[1] Vespignani, A. “Modelling dynamical processes in complex socio-technical systems " Nature Physics Volume 8, No 1 (2012).

[2] Bazzani A.; Giorgini B.; Gallotti R.; Giovannini L.; Marchioni M.; Rambaldi S. “Towards Congestion Detection in Transportation Networks Using GPS Data” IEEE International Conference on Social Computing (SocialCom-2011). Boston (USA). 9-11 October 2011. (pp. 1455 - 1459). ISBN: 978-0-7695-4578-3. PISCATAWAY, NJ: IEEE CONFERENCES, (2011).

[3] Bazzani A., Giorgini B., Giovannini L., Gallotti R., Rambaldi S. “Now casting of traffic state by GPS data. The metropolitan area of Rome.” MIPRO, 2011 Proceedings of the 34th International Convention , Opatija. May 23rd to 27th 2011. (pp. 1615 - 1618). ISBN: 978-953-233-067-0. RIJEKA: IEEE CONFERENCES, (2011).

[4] Daganzo C. F., Geroliminis N. “An analytical approximation for the macroscopic fundamental diagram of urban traffic”, Transportation Research Part B- Methodological, 42(9), pp. 771-781, (2008).

[5] Geroliminis N., Daganzo C.“Existence of urban-scale macroscopic fundamental diagrams: Some experimental findings”, Transportation Research Part B-Methodological, vol. 42(9), pp. 759–770, (2008).

[6] Schönfelder, S. and Axhausen, K. W.” Urban Rhythms and Travel Behaviour: Spatial and Temporal Phenomena of Daily Travel”, Ashgate, Farnham, UK (2010).

[7] Brockmann, D., Hufnagel, L., Geisel, T. “ The scaling laws of human travel” Nature 439, 462-465, (2006).

[8] Song,C., Koren,T., Wang,P. and Barabási A-L “Modelling the scaling properties of human mobility”, Nature Physics 6,818–823, (2010).

[9] Bazzani, A., Giorgini, B., Rambaldi, S., Gallotti, R., Giovannini, L., “ Statistical laws in urban mobility from microscopic GPS data in the area of Florence" JOURNAL OF STATISTICAL MECHANICS: THEORY AND EXPERIMENT. vol. n. 05, pp. P05001, (2010).