Pedestrian Mobility: a statistical physics approach based on GPS data

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Modeling human mobility has been considered a paradigmatic example for the application of the Complex Systems Physics since one may take advantage from a Statistical Physics approach introducing cognitive effects in the microscopic dynamics. The problem of crowd dynamics in a complex road network has both relevance for safety reasons and for the sustainability of the future great tourist flows in the historical cities like the Venice. Various authors have proposed statistical laws to describe the complex features of human mobility using the large data bases (Big Data) provided by the Information Communication Technologies, but the definition of dynamical microscopic models able to describe transient or non-equilibrium states of the systems and to perform a forecasting of mobility state on a road network is still a debated problem due to the difficulty of recording dynamical data at microscopic level. Here, we show a study of pedestrian mobility in Venezia during Carnival 2017 based on the GPS localization of mobile phones. These data provides the lat-lon coordinates of a smart-phone that activates specific application on a relevant sample of the population(30% of the smart-phone population). The mobile phone data sample is validated using the pedestrian flows estimated from videos and photos recorded during the Carnival on locations of particular interest.

Our results concern the daily evolution of tourist distribution in the city during the Carnival detecting and quantifying the most crowded areas, the reconstruction and the characterization of the individual paths on the road network and of the individual mobility demand, and the study of the predictability of the mobility state using a nonlinear random walk dynamical model on the road network. We analyze the properties of the Master equation that describes the stochastic evolution of the system where the transition probabilities depend on the time-varying mobility demand and the crowding effects. We also study the fluctuations properties of local densities and flows to understand their correlation with the presence of criticalities (overcrowding) in the considered area.

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