Human mobility study: Using Mobile Phone Data for Simulation and Transportation Research

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Abstract

Mobility forms one of the most intriguing aspects and, sometimes, problems of contemporary society. People's mobility does not only form and shape their own experiences; mobility is also one of the structural forces behind many complex constructions that guard our daily lives. Understanding the rules that govern individual mobility offers insights about strategic planning and management of transportation networks. In fact, studying the daily flows of migrant populations is an essential step for enabling administrative authorities to optimize the use of their transportation networks, not only for the benefit of users on their daily journeys but also with a view to the investments required to adapt these infrastructures to envisaged future needs.

Many sensor mobility data dealing with the position of individuals have become available due to the wide deployment of pervasive computing devices. Data mining can be put to work to analyze these data, with the purpose of producing useful knowledge in support of sustainable mobility and intelligent transportation systems. In this context, mobile phone data have received increasing attention in the past few years and have become a crucial source of information to conduct human mobility studies (Wang et al. 2017). For instance, these massive datasets are becoming one of the important means to monitoring real-time traffic status (Calabrese et al. 2011), estimating travel demand (Frias-Martinez et al. 2012) and understanding mobility patterns (Calabrese et al. 2013).

This Research works seek to understand and infer individual mobility and travel behaviors in urban areas by exploring a recent large dataset of mobile phone digital footprints. The aim of the thesis is to study the city dynamics using the Big Data analysis techniques and highlighting the interdependence of the different mechanisms governing the city such as population distribution and land use.
The proposed research aims to investigate mobile phone traces in order to determine the reliability of such data in 1) estimating the number of residential and 2) constructing origin-destination (OD) matrices.

For this objective, we have performed mobility analyses by exploring a dataset issued from Orange mobile network probes (2G/3G). These probes aim at capturing user location data by monitoring every service demand request occurring between the mobile device and the 2G or 3G network. The dataset contains recordings of several days of over 1.2 million mobile phone users per day. Spatially, it covers a territory from Rhône-Alpes region including Lyon city. The main advantages of using passive cell phone data in mobility studies consist that they are more cost-effective, less biased and available on a much larger scale (both in space as in time) compared to traditional data collection methods such as household travel surveys and public transport surveys. The

spatiotemporal continuity makes our dataset of better quality, allowing us therefore to perform fine grained analysis on both individual and community level.
Using the provided data, we have first checked the potential of mobile phone data to estimate the home locations of the involved anonymous users (Frias-Martinez et al. 2010, Calabrese et al. 2011). Hence we propose an algorithm to automatically identify the residential location of cell phone users based on their device activity. For each user, we derive the most frequent used antenna in the night time interval and consider it as his/her home location. Then, we aggregate the identified home locations to get the number of residential per municipality.
INSEE ("Institut National de la Statistique et des Etudes Economiques") census data have been used to verify the accuracy of home location identification technique after resolving the problem of matching between the different zoning systems used in the two studied data sources. By investigating the obtained findings, we demonstrate that the population estimated from mobile phone users' home locations scales linearly with the INSEE Census data.

As a second step, we will focus on extracting stay points and detecting users' trips from their home locations in order to generate origin-destination (OD) matrices as performed in (Çolak et al. 2015, Bonnel et al. 2015). The contribution of this work will be not only in using very recent cellular network traces, but also in exploring other data sources to be able to validate our results. We benefit from a travel survey data to validate the estimated OD matrices from mobile phone data. Thus, we will present a comparison with the data from the household travel survey ("Enquête Déplacements Régionale") conducted in Rhône Alpes region in 2015.

The possibility to use both mobile phone traces and transportation survey data offers an excellent validation framework. Therefore, it allows us to better characterize the studied urban area, which is useful to infer high-level mobility patterns, and to develop accurate predictive models giving us a long-term estimation of commuters' mobility and travel behaviors.

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