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Investigating the mobile phone data to estimate the origin destination flow and analysis; case study: Paris region

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Abstract

This paper is an output of a French national project called iSpace&Time aiming to provide a 4 dimensional platform of an urban dynamics. In order to express the urban traffic, we took an advantage of the mobile phone data to investigate the behavior of the origin destination flow within the Paris and its suburb aiming to explore the different mode of the transportation. Indeed the spatiotemporal heterogeneities of mobile phone data make the task of mode of transportation separation very challenging, sometimes even impossible. Thus, by exploring the OD matrix in order to revealing any probable continues trends or any dominant trace of the flow stating a specific mode of transportation, the commuter trains happened to be somehow detectable. Then an individual-based step-by-step approach is proposed to estimate mode of transportation from mobile phone data. Analyzing the individual trajectory, the decision is given to a segment level with respect to different measures. An early promising outcome consists of detection of the segments in which people would take the metro.

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Keywords: mobile phone data; origin-destination matrix, transportation mode, smart data processing;

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1. Introduction

This work was carried out on behalf of the iSpace&Time French ANR project whose primary goal is to propose an online 4D urban geo-portal platform allowing to integrate different sources of data in order to develop a tool to visualize urban area in 4 dimensions. This platform will empower the decision makers in land-use projects and urban planning studies or equipped the engineers to employ and update reference data by crowded sourcing processes. To achieve this goal, one of the steps is to generate mobile objects (e.g. cars, pedestrians, etc.) by merging data coming from different sources (e.g. mobile phone data, sensors data, surveys). Basically generated mobile objects are the input of such urban model allowing 4D simulations in an urban network.

Mobile devices are becoming ever more common hardware choice due to the sensors they provide, their cost-effectiveness, and their high presence amongst users. The popularity of mobile phones made it relatively easy to obtain the contextual data they provide. As a matter of fact it provides a unique potential for contextually aware systems by providing them with a large user base that already carries the necessary hardware around with them regularly. Therefore, collection of these data can be extremely valuable in transportation science. They can be used for investigation of the mode choice behavior, origin-destination matrix estimation, transportation demand modeling in a more realistic manner.

Although, the distinction of transportation modes plays a key role to enrich the content of urban displacements, very few studies investigated the transportation modes from the traces of mobile phones in urban areas. This mode identification generally applies for origins-destinations estimation on a large scale rather than the small ones, for example between two cities.

Our goal is to separate the transportation mode in urban areas by using mobile phone data. The estimation of transportation mode happened to be a very difficult task due to the characteristics of mobile phone data such as location accuracy, miscommunication of the individual in which the tracking is done only if an event communications or update of position takes place. Thus the frequency of records is not constant, the location depends on antennas locations and no semantic information exists.

In this context, our idea is to propose an experimental method that gradually leads towards the derivation of the transportation mode. First, we are tempted to classify the transit modes not only taking the topology of the study area into account, but also considering the essence of urban transportation from point to point. In this purpose we first generate and then explore the OD flows in order to quantify the probabilities of distinction of those modes that supposed to likely following their fixed routings. Consequently, a comprehensive study has been done over one day anonymous mobile phone data in urban area received by a French telecommunication operator called Orange. The test area covers the whole Paris Region containing Paris and its suburbs.

The paper is structured as follow: right after in the next section the related research is presented. Section 3 briefly describes the characteristics of the mobile phone data which has been conducted in this study. Section 4 represents the OD flow construction methodology. Section 5 studied the urban dynamics related to the flow in favor of early mode split trends. Section 6 proposed ideas for a step-by-step approach of transportation mode distinction and finally the conclusion and the proposition for further studies are provided.

2. Relevant study background

Several research proposing methods to estimate transportation mode for data coming from sensors exist in the literature. Such transportation data can be used in many applications such as traffic analysis, determination of the CO_2 footprint, public transportation policy and urban planning projects. Most approaches applied on GPS data which use the speed (average, median, maximum and last percentile) as one of the most discriminating criterion (Schüssler and Axhausen, 2009; Stopher et al., 2008). Other criteria such as the travel distance in relation to the urban topography or transportation network (Biljecki et al., 2013), speed acceleration (Zheng et al., 2008) or