Uncovering mobility typologies of territorial zones based on Floating Car Data mining

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Abstract

This paper describes a data exploration study using Floating Car Data to analyze mobility patterns of geographical spaces. The objective is to build a mobility-related typology of territorial zones by investigating the related vehicle movements. Mobility features at the level of stays and trips are recovered from daily vehicle trajectories. Based on the features of stays that take place in each zone and the related trips, we characterize the functional mix of human activities of the zone and its interactions with the rest of the territory. A multi-feature clustering analysis is conducted to feature out such zonal mobility patterns in terms of trip generation and attraction, activity time and duration and zonal users’ anchor places (the individual homeplace and workplace), as well as the temporal variation among hours and days. Further spatial statistical analysis is conducted to identify spatial subsets of zones with respect to their mobility patterns, thus aiding to understand the territorial organization. Overall, this study provides a data-driven approach to study mobility interactions with territorial spaces, by spatial segmentation, characterization and differentiation.

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Keywords: Territorial mobility pattern; Space clustering; Mobility typology; Floating Car Data;

Introduction

Understanding mobility pattern has been widely acknowledged as a critical role in urban planning, traffic management and many other place-based applications. Generally, spatial configuration may induce mobility generation, while reversely, human movement would further re-impact the space development (Huang et al., 2016). The evolution between them is reciprocal. Therefore, investigating the mobility pattern of territorial spaces will help to reveal such an interaction and provide valuable guidance for future development. With the growing diffusion of location tracking technologies, digital traces are becoming more and more available nowadays. Among them, Floating Car Data (FCD) has emerged as a new essential data source on roadway traffic for a high spatial and temporal coverage, which thus offers a great potential to investigate mobility patterns of territorial spaces.

In existing literature, FCD was mainly used to determine traffic states, including speed detection, travel time estimation, and congestion prediction (Altintasi et al., 2017; Fusco et al., 2016; Mori et al., 2015). Mobility perspective analysis using FCD was relatively scarcely investigated. Among those works, some studies analyzed the city structure by deriving hotspots and point of interests from taxi pick-ups and drop-offs (Jahnke et al., 2017; Liu et al., 2015). Major hubs such as airports were also analyzed to further investigate its specific mobility role interacted with the city (Ding et al., 2016). Some other studies analyzed mobility origin-destination patterns aiming to extract major spatial movement and their temporal variations (Ciscal-Terry et al., 2016; Lian et al., 2018). Yet the related studies hardly dealt with the detailed mobility pattern on each intra-homogenous geographical space unit, namely territorial zone at a regional level. Another persistent issue in most of those studies is the lack of focus on the activity stay following the movement, which leads to the role with space occupation. Therefore, the objective of this study is to investigate the mobility pattern of territorial zones by mining the trip movements and activity stays from...
Floating Car Data. By building a mobility profile in terms of trip departure, arrival and related vehicles’ activity context as well as their hour and weekday variation, this research aims to cluster and characterize mobility pattern of territorial zones so as to build a typology.

**Research contribution**

This research aims to provide a methodological approach to uncover territorial space mobility functions by mining FCD. A statistical trip segmentation is built for recovering trip information to offer a way of describing place mobility pattern in terms of trip patterns. A multi-feature clustering-based method is proposed to explore zonal mobility patterns temporally and spatially. Practically, this research provides a big data driven instance to analyze mobility interaction with geographical spaces, the knowledge of which may provide useful insights in understand their heterogeneity and similarity in a quantitative way.

**Methodology**

The research framework mainly involves the following analysis:

- **Zone mobility profile building**: Raw FCD time sequences are firstly processed to extract valid trip information within each territorial zone. A trip segmentation statistical model is built to segment traces into meaningful trips by considering between trip time intervals, distance deviation and gap average speed. On top of that, a set of trip features including trip departures, arrivals, activity dwelling time and trip traveling distance are aggregated at each zone level to represent its mobility profile.

- **Zone mobility pattern clustering**: Clustering analysis are applied on those zone profiles from multiple aspects: 1) to explore the trip generation and attraction pattern, hourly trip departure/arrival count series are clustered among zones. 2) To reveal the pattern activity time duration, short/medium/long activities are pre-classified with range thresholds by inspecting the distribution. Such classified activities are then counted hourly and used for further clustering the pattern of activity duration along the day. 3) Traveling distance for trips coming to and from each zone is also clustered along with their temporal variation so as to reveal the pattern of its mobility outreach range. Zonal users’ anchor places, such as homeplaces and workplaces can also be inferred from their regular patterns of traces and used to aid the clustering analysis. Different clustering techniques are employed and compared to reach final optimal results.

**Application and results**

The proposed methods are applied over the Great Paris region for a case study. Two days of Floating Car Data are used for the analysis, including a typical weekday (Thursday) and a day during the weekend (Sunday). Data are collected from Coyote, a roadway information service provider, covering the subscribed users in an anonymous way. The zones of IRIS (Islands Grouped for Statistical Information) are used as the territorial space analytical units. Such zones are subdivided on an infra-municipal scale by INSEE with homogeneous district and habitat property. Different groups of zones are expected to be drawn from the above-mentioned multi-feature clustering analysis in terms of residence vs commercial, activity duration probability and accessibility ranges. Statistical analysis is further conducted to find out prominent features within each aspect of clusters and significant correlations between different aspects of clusters, thus helping to categorize the mobility typologies of territorial zones.

**References**


