Can FCD data indicate problems in urban planning? A case study in Shanghai

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Abstract

The current advanced technologies in hardware and software for positioning, such as embedded GPS receivers in mobile devices, have eased the acquisition of massive movement data. For example, personal locations can be obtained and registered in social media platforms only by a simple click on APPs installed on a smart phone. When driving with cars, their locations can also be acquired without any effort by embedded GPS devices in the car systems. At the present, a large number of taxi companies are collecting the positions of their taxis for the purpose of management and better dispatching. In the research society, this kind of mobility data is regarded as valuable, because, it describes the changes of spatial positions of the mobile objects and provides the possibilities to investigate the urban dynamics. For instance, in intelligent transportation system, floating car data (FCD) collected at a relative low-cost can provide up-to-date high-quality traffic information (Huber et al. 1999).

To this date, the most of researches using mobility data are focusing on the analysis of trajectories of moving objects to explore the characteristics of user behaviors. For instance, Yuan et al. (2012) presented a recommender system for both taxi drivers and taker using the knowledge of both passengers' mobility patterns and taxi drivers' picking-up/dropping-off behaviors learned from the GPS trajectories of taxicabs. Liu et al. (2012a, 2012b) examined large amounts of floating car data and mobile phone data respectively to understand human mobility patterns. In visual analytics, interactive visualization of movement data both at local scales

focusing on individual trajectories (Guo et al. 2011, Tominski et al. 2012), or at large scales emphasizing on aggregated data (Andrienko and Andrienko 2011, Andrienko and Andrienko 2013) have been comprehensively studied to extract significant traffic mobility patterns.

This paper attempts to find problems in urban planning by using FCD data. Most concretely, we try to identify the problems of missing taxi pivots in large public service centers by investigating the chaos situation of taxi drivers' picking-up/dropping-off behaviors in the surrounding of these public service centers. Our experiments were conducted using the FCD data in Shanghai. The test dataset are temporally ordered position records collected from about 2000 GPS-enabled taxis within 47 days from 10th May to 30th June 2010, in Shanghai. The temporal resolution of the dataset is 10 seconds and thus theoretically around 8000 GPS points of each car would be recorded in one day (24 hours) given the GPS device effective. Each position record has nine attributes, i.e. car identification number, company name, current timestamp, current location (longitude, latitude), instantaneous velocity, and the GPS effectiveness. In further, car status is recorded either as occupied or as non-occupied. From this data, the actions of drop-off and pick-up can be derived.

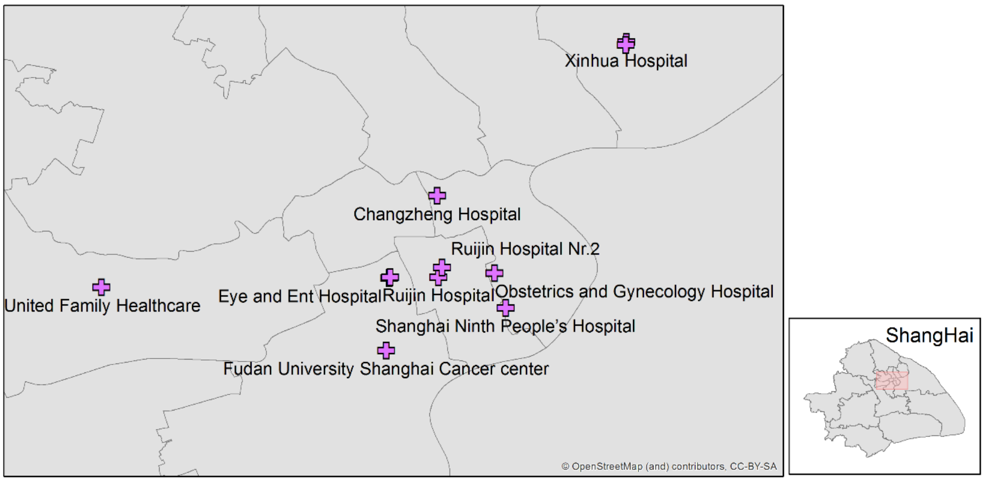


Figure 1. The investigated hospitals in the study area

As shown in Figure 1, nine most important and famous hospitals are selected as test targets based on our local knowledge in Shanghai. We took the data near these nine hospitals (with a buffer zone of 500m) within the time duration of 7 am to 9 am on the May 10, 2010, which was arbitrarily selected for the investigation.

The locations of drop-off events in the surrounding of these nine hospitals are visualized in Figure 2. Obviously, on the roads near the entrances of every hospital, the drop-off are significantly more than other streets. For a better visual comparison, the density maps are calculated by using the technique of kernel density estimation (KDE). The results of the density maps are demonstrated in Figure 3.

The passengers dropped off from taxis in the surrounding of a hospital from 7am to 9 am might be staffs who are working at the hospital. But most of them should be visitors of the hospital. From Figure 2 and Figure 3 one can see that the whole road segments directly near the entrances of these nine hospitals are densely distributed with taxi drop-off events. Normally, every drop-off takes two to three minutes in average which corresponds a temporary parking directly on the street. If we take the deceleration for drop-off and the start up for leaving into account, a taxi may stay more than five minutes at the same location (or with 3-5 meters offsets). When a large number of taxis drop off their passengers within similar time duration, the streets will be certainly occupied by taxis. One might notice that taxis came from both directions. That means that some passengers crossed the streets directly from where they were dropped off. As a result, traffic jams occurred, because there are also public buses, personal cars, and electrical motorcycles on the streets. The reality is that there are almost every day several traffic jams on these streets in Shanghai.

The nine hospitals selected for the test study are renowned general or specialized hospitals in Shanghai with the rank of "Grade 3, Class A. Actually, they are well-known in the whole China because of their world-recognized medical scientists and experts, as well as the best medical equipment. Therefore, visitors come also from other regions and provinces in the country. They may take taxis to hospitals from train stations or hotels. Besides, the most of local visitors (patients from Shanghai) may also prefer to take taxis to hospitals due to the overloaded underground trains on the one hand. On the other hand, all these nine hospitals are not located directly near an underground train station.

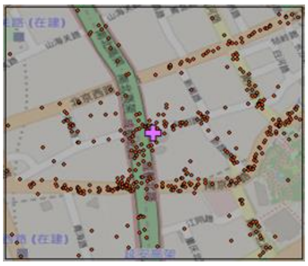
For this kind of situation there should be at least special zones (or even better underground taxi pivots) for taxi drop-off and pick-up near these hospitals. Unfortunately, the reality looks more worth. None of these hospitals are designed and constructed with pivots for taxis. Therefore, people have to suffer from traffic jams several times in a day.

The density maps of taxi drop-off events could help to understand this problem intuitively on the one hand. On the other hand, it can indicate the potential entrances and exits of underground taxi pivots in the urban planning.

(1) Ruijing Hospital and Ruijin Hospital No 2

(2) Fudan University Shanghai Cancer center

(3) Xinhua Hospital



(4) ChangZheng hospital

(5) Eye and Ent Hospital of Fudan University

(6) United Family Healthcare

(7) Obstetrics and Gynecology Hospital of Fudan University

(8) Shanghai Ninth People's Hospital, Shanghai JiaoTong University School of Medicine

Figure 2. The extracted pick-up events around the investigated hospitals (within a 500m buffer) of on the 10^{th} May, 2010

(1) Ruijing Hospital and Ruijin Hospital No 2

(2) Fudan University Shanghai Cancer center

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(5) Eye and Ent Hospital of Fudan University

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Figure 3. The kernel density (with a radius 60m) of the extracted pick-up events around the investigated hospitals (within a 500m buffer) of on the 10th May, 2010

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