

Chapter 9

Care to Share?

Using GPS Fleet Data to Assess Taxi Sharing

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ABSTRACT

GPS technology has been extensively used to optimize operation of taxi systems since the first appearance of commercial GPS devices. Owing to this, data sets generated by taxi fleets are amongst the first and most representative examples of massive GPS data that have been systematically collected. The analysis of these data sets has recently generated a rich literature aimed at, among other things, identifying optimal taxi driver strategies, predicting taxi demand or location of vacant taxis, etc. This chapter focuses on what is a new, exciting field of investigation of GPS taxi data analysis, namely, evaluating the impact of a shared taxi system on the urban environment. After introducing the notion of (taxi) ride sharing, the chapter presents the relevant literature, describing in greater details a methodological approach called “shareability network” that allows formal characterization of taxi sharing opportunities in an urban environment.

DOI: 10.4018/978-1-4666-8465-2.ch009

INTRODUCTION

In recent years, spatio-temporal data sets have been used extensively to characterize human mobility at the urban, regional, national, and international scale (Calabrese, 2011; Gonzales, 2008; Song, 2010). GPS data has proven especially valuable to this purpose, given its high spatial and temporal resolution compared to other data sets - such as cell phone records. Let's look at the difference between GPS and cell phone data in more detail. A GPS device typically logs the position with a frequency in the order of seconds or, at most, a few minutes, and a spatial accuracy of the order of tens of meters (the latter can be actually much higher if GPS is used in combination with digital maps and map matching algorithms). Conversely, cell phone data typically have a spatial accuracy of the order of hundreds of meters or a few kilometers (depending on the coverage area of cell towers), and a temporal resolution, which is heavily dependent on how "active" a cell phone user is. Even in case of very active users, however, position is tracked with a resolution of the order of a few minutes. Based on the example above, it is not surprising that GPS data is considered particularly valuable to those interested in studying human mobility.

One of the most established collection of GPS data sets that have been analyzed in the literature deals with taxi systems. In their drive to optimize fleet management, taxi companies have been among the first adopters of GPS technology. Vast collections of taxi GPS traces have been collected across the world since over ten years. Such data is particularly interesting for researchers for at least two reasons:

- 1) It can be used as a sample of individual human mobility in urban environments, contributing to the definition and/or validation of urban mobility models;
- 2) It can be used to better understand the dynamics of vehicle fleets, which are a very relevant component of urban transportation systems.

As a result, the analysis of GPS taxi data has produced a rich literature in the field of GIS, data mining, mobility modeling, and urban transportation. In the realm of traffic and urban mobility modeling, Aslam et al. (2012) show how traffic volume can be estimated in real time through taxi data, while Liu et al. (2011) focus on discovering spatio-temporal interactions in traffic patterns. With the goal of characterizing the dynamics of taxi systems, several authors have studied taxi driver's strategies that maximize profit (Liu, 2010), methods for predicting taxi demand (Huang, 2012; Yuan, 2011; Zhang, 2014), and identification and prediction of vacant taxis (Phithakkitnukoon, 2010).

One of the most interesting applications of GPS taxi data analysis is evaluating the impact of ride sharing on the urban environment. In fact, the burgeoning "sharing economy" phenomenon, i.e., the collaborative consumption of shared resources

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