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The Challenge of Obtaining Ground Truth for GPS Processing

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Abstract

The increasing use of GPS as a source of travel survey data has brought with it an increasing need for a reliable source of ground truth. Recently, the main source that has been used for providing ground truth is the prompted recall survey. However, the prompted recall survey is subject to many of the same shortcomings as most self-administered surveys. In this paper, we review some of the common problems encountered in prompted recall surveys. Following this, we describe a recent experiment in using life-logging cameras to record a person's travel, together with GPS, thereby providing a new source of ground truth data.

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1. Introduction

Over the past two decades, GPS surveys have moved further and further into the mainstream of household travel surveys, having initially been used primarily as a validation tool for conventional diary surveys, until recently when there have been several instances of GPS-only household travel surveys being undertaken (e.g., Oliveira et al., 2011; Stopher et al., 2013a). There seems to be little debate now about the fact that GPS devices can collect much more accurate data about travel than any previous method of surveying the public. GPS devices are capable of recording the position of a person every second, and can therefore show accurately the time at which the travel took place, the route that was travelled, and (assuming the device is equipped with the appropriate capability) the speed of travel. All of these elements are collected with much greater detail and accuracy than has ever been possible from any form of interrogation of survey respondents. However, just as the GPS device can collect extremely accurate information

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on position, time, and speed, the device is not able to record information about when a trip starts and ends, what means of travel is used on each segment of a trip, what the purpose is of the trip, and who might be accompanying the survey respondent on the trip. Fortunately, over the time that GPS has emerged as an increasingly interesting device for collecting travel data, quite sophisticated methods have been developed to infer the missing information from the data collected by the GPS device, together with the reporting of some contextual and other data collected from respondents as part of their household, person, and vehicle attributes.

While software has become increasingly sophisticated over the past decade or so, there remains a persistent issue – how to assess the accuracy of the inferences. What is needed for this assessment is what has been termed “ground truth”. Ground truth is the knowledge of what the respondent really did while carrying the GPS device. It is essential if assessment of the accuracy and realism of inferential software is to be achievable. Not surprisingly, some of the reluctance to move away from conventional survey methods (self-administered and interviewer administered surveys) can be laid at the lack of objective assessment of the accuracy of the inferred characteristics from a GPS survey. In controlled experiments, it is possible to gain relatively good ground truth, by instructing those participating in the experiment on what travel activities to carry out while carrying the GPS devices. Even here, there can be a problem of a person deciding not to follow the exact instructions or encountering a situation in which the exact instructions cannot be followed. There then exists the unreliability of recounting what actually happened, especially with sufficient detail as to verify the correct ground truth of the travel. Outside of controlled experiments, however, the acquisition of ground truth becomes quite challenging. In the next section of this paper, we explore some of the potential sources of ground truth and discuss the extent to which these sources measure truth with sufficient accuracy and reliability to be used as a yardstick against which to assess the outcomes of inference from GPS data.

2. Potential Sources of Ground Truth

For the purposes of this section of the paper, we ignore controlled experiments, because the most important aspect of determining ground truth must continue to be determining it in situations where there is no control. In other words, the most important context within which ground truth needs to be measured is that of the practical sample survey.

2.1 Diary Surveys

Not a few researchers have reported an assessment of proposed software procedures against data collected by a standard conventional travel diary, usually collected for a single day (references). Unfortunately, the early applications of GPS to validating diary surveys showed the unreliability of the conventional diary as a mechanism to collect data about travel. Assessed against the attributes that GPS collects unquestionably, it was found that people omitted trips (about 20 percent seems to be the average rate of omission), reported trips as taking more time than they do in reality, and also reported trips as being a shorter distance than is the reality. In addition, a more detailed study of the discrepancies between GPS records and diary records (Stopher and Shen, 2011), shows that some trips are reported to take place at a different time of the day than was actually the case, sometimes are even on a different day, may also have gone to a different place than reported in the diary, or may not have taken place at all. Most of these studies have been restricted to looking only at the trip and not at mode of travel and purpose of the trip. However, it can be expected that there will be similar errors in mode and purpose, resulting largely from respondents completing diaries retrospectively and relying on faulty memory to do so.

Furthermore, if GPS is being put forward as a more accurate method of collecting travel data than the conventional self-report travel diary, then it seems to be somewhat illogical to turn to diaries as a way to check the accuracy of inferred results from the GPS survey. It is, perhaps, indicative of the challenge and accompanying frustration to achieve ground truth that has led a number of researchers to rely on such a source for ground truth.

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