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Travel time estimation between loop detectors and FCD: A compatibility study on the Lille network, France

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Abstract

The availability of floating car data (FCD) enables operators to use novel methods in travel time estimation. A first step towards combining traffic data from loops and FCD is to check the compatibility between the two types of travel time estimates. We perform an in-depth statistical analysis that allows us to compare various travel time estimates using data collected from the peri-urban highways in the region of Lille, in north France. The comparison is performed separately for light and heavy vehicles and for various settings: peak hour, off-peak hours, working day, holiday, rain, and so on. The results show that the two estimates are linearly correlated and a specific function can be calibrated for each site for itineraries of variable length. Overall, this paper provides evidence that different flow regimes necessitate differentiated a priori treatment in order to enhance the reliability of estimates made on data coming from different sources.

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Keywords: loop detectors; FCD; travel time; data compatibility

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1. Introduction

Advanced traveler information systems (ATIS) are being deployed at a large scale internationally. Communications and display technologies now allow for the provision of key travel information to drivers in real time and, thus, introduce a new era in infrastructure management strategies. Real time information can be either prescriptive or descriptive and it may be provided either pre-trip or en-route. Information provision aims to assist drivers in decision making and to enhance travel safety and comfort with additional benefits to the overall system performance. Informed drivers can make more rational choices regarding route choice conditional upon travel time and travel time reliability.

Numerous studies provide evidence on the importance that drivers give to travel time information under normal traffic conditions as well as in the case of accidents, works, adverse weather, or special events. In Europe, most infrastructure management systems continue to use conventional inductive loop detectors to collect the necessary input data. In the latter case, infrastructure operators apply a site-specific algorithm to provide reliable travel time estimations to motorists.

Yet, the availability of floating car data (FCD) enables operators to use novel methods in travel time estimation. The principle of FCD-based methods is to collect real-time traffic data by locating the vehicle via mobile phones or GPS over the entire road network. Private parties provide FCD data that may cover parts of the network with or without inductive loop equipment. FCD either replace loop data if necessary (unavailability, technical failure, etc.) or they are combined with loop data in order to enhance travel time estimates.

A first step towards combining the two data sources (i.e. loops and FCD) is to check the compatibility between the two types of travel time estimates (i.e. prior to the application of predictive algorithms). The objective of this research effort is to perform a compatibility analysis using statistical tools in order to identify specific error patterns or physical inconsistencies. In this paper, we present the work undertaken so far for the case of the peri-urban highways in the region of Lille, in north France. We perform an in-depth statistical analysis that allows us to compare various travel time estimates. The comparison is performed separately for light and heavy vehicles and for various settings: peak hour, off-peak hours, working day, holiday, rain, and so on.

After a short background on FCD and loop data comparison (section 2), we present the site of the study (section 3), and we describe the algorithms and the data sources that are currently used for travel time estimation (section 4). Next, we present the data set and perform the comparison analysis (section 5). Finally, results are discussed and future research recommendations are provided (section 6).

2. Background

Over the last decade, a great number of researchers have explored the possibilities offered by FCD technologies with particular emphasis on travel time estimation (see, for example, Chen and Chien, 2001; Zheng and van Zuylen, 2012) and prediction (see, for example, Gunawan and Chandra, 2014). Some of them go even further by augmenting FCD data by weather or other real time data known to have an impact on flow (Qiao et al., 2012). The sample-size and the choice of an appropriate extrapolation technique have also attracted considerable attention. Furthermore, researchers constantly explore possible techniques that could improve algorithms and systems for generating FCD from GPS position (see, for example, Kuhns et al., 2011). Travel times from actual vehicle trips are compared with travel times as they result from the FCD algorithm and suggestions for improvement are made.

However, it remains an open question which technology is closer to the 'ground truth' and can be taken as a reference baseline for system evaluations. In Liu et al. (2012), the data collected by TRANSMIT readers, Bluetooth sensors, and INRIX were assessed by comparing each to the 'ground truth' travel times collected by probe vehicles carrying GPS-based navigation devices. Automatic number plate recognition (ANPR) has been used also as reference measurement. Using ANPR, Brockfeld et al. (2007) concluded that FCD system is particularly able to detect jammed situations and the travel times calculated. Graser et al. (2012) found that the FCD system detects travel time peaks in case of congestions more robustly than stationary sensor infrastructure although very high peaks are not recognized to the full extent. Rahmani et al. (2015) also used ANPR data along several routes to assess and correct for possible FCD inherent bias in TT estimates.