Exploiting the relation between Activity Data and Traffic Data within the Dynamic Demand Estimation Problem

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Context and motivation:

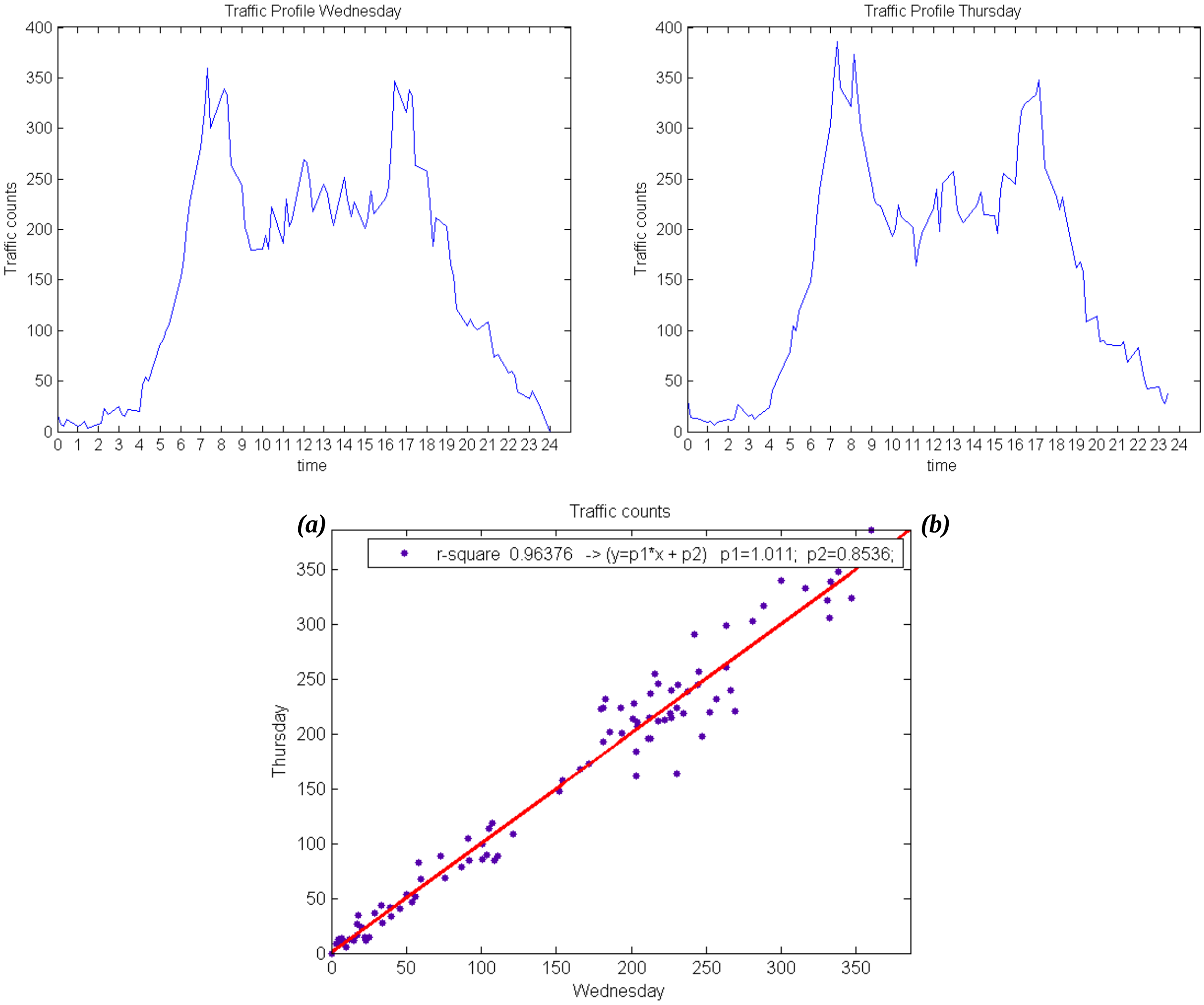
The Dynamic Demand Estimation (DDE) problem searches for time-dependent demand matrices; to solve this problem, in the classical approaches, survey data and traffic data are used [1-4].
In this paper an explorative analysis is conducted, with the goal to capture and analyze the existing relation between the traffic demand observed with the classical traffic counts and the activity patterns of the users. The aim is to exploit information from daily and weekly activity-travel patterns to use as input in the DDE problem, for example to enrich the (time-dependent) seed matrix. Activity data are already studied in the traffic engineering for different applications; many works in the literature underline the relevance to establish a relation between the trip chains and the activities within the day for each user, highlighting that generally the trip is motivated from a specific purpose (Ettema and Timmermans [5]). A fundamental aspect in the research is to understand how the users of the traffic network schedule their trips taking into account different elements related to recurrent and non-recurrent household activities [6]. Various scheduling models are proposed in literature to obtain the scheduling of the activity pattern and activity travel behavior ([7-8]) and integrate them in travel choice processes using a supernetwork approach [9]. These models are directly combined in simulation tools, like Albatross (TU/e [8]) and MatSIM (ETH, TU Berlin [10, 11]). In this case the traffic simulation takes into account the activity scheduling of the users to estimate the departing time. The research on the activity-based models is becoming even more important as more and more activity-related data are available through the new information and communication technologies and the spread of social networks; data collected from social platforms such as "foursquare" provide frequent, accurate and cheap information on various activities, their location and the check-in times of social network users. Similar features can be found in other social networks (e.g. Facebook, twitter). On the other hand it is to highlight that, although the authors stress the relation between departure time and activity information, there are only few works that use this information in the demand estimation problem and generally they are limited to the static Demand Estimation problem; A recent example in this case is a case study on the city of Austin [12].

Methodology:

Taking into account the above considerations, this explorative analysis aims to obtain from the activity data taken from a multi-day survey a new input for the DDE problem. In the classical DDE approach, dynamic data on the initial demand are missing, so often it is used a target matrix derived from static models in the correction procedure. Instead, the Activity Data provide temporal information about the distribution of the demand, for this reason it is advisable to use those data in the estimation problem rather than the target matrix. To obtain this information from the activity data, it is necessary to understand the difference and the commonalities with the traffic data. Indeed traffic detectors give different information useful to the demand estimation problem, as the temporal profile of the demand on the specific roadway section. The temporal profile of the demand is a fundamental parameter adjusting the time depend demand matrix, but the information from the traffic data are strongly aggregated, and this could often generate biases in the estimation procedure. In this study we analyze the database collected in the BMW (Behaviour and Mobility within the Week) project, which was carried on by KU Leuven and the University of Namur in 2008 and were activity patterns and trip chains where collected from a 6-weeks survey involving more than 500 participants. Specifically, individual respondents provided for two consecutive weeks information about their trips, together with relevant information on their trip purposes. For every respondent full within-day and day-to-day activity chains and activity trips are therefore available. In parallel, traffic data was obtained from several locations in the same region, so that a conventional dynamic OD estimation from traffic data could be performed.

<u>Summary of the results:</u>

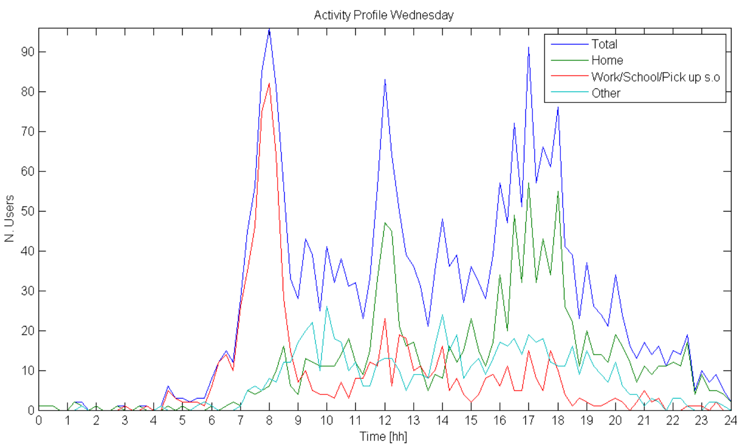
The first step of the analysis was focused on the comparison of the trend of the observed demand, obtained from traffic data, with the trend of the aggregate Activity Function. In figure 1(a) and 1(b) is possible to observe the measured flows on a specific detector on Wednesday and Thursday.

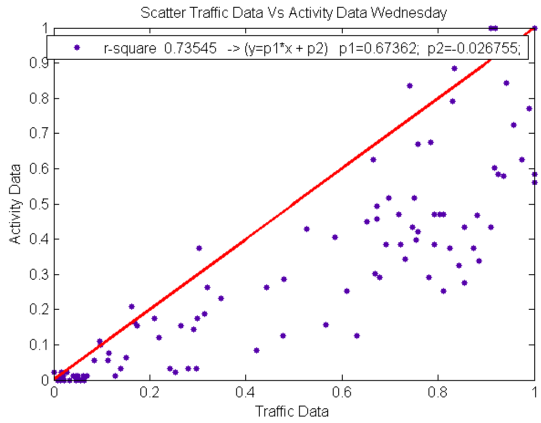


(c)

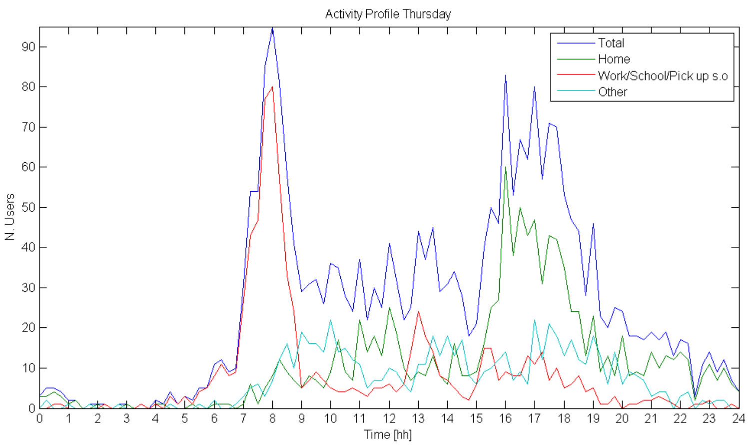
Figure 1: (a) Observed traffic Flow on a detector Wednesday 10/09/2008; (b) Observed traffic Flow on a detector Thursday 11/09/2008; (c) Scatter between observed measured on Wednesday and Thursday.

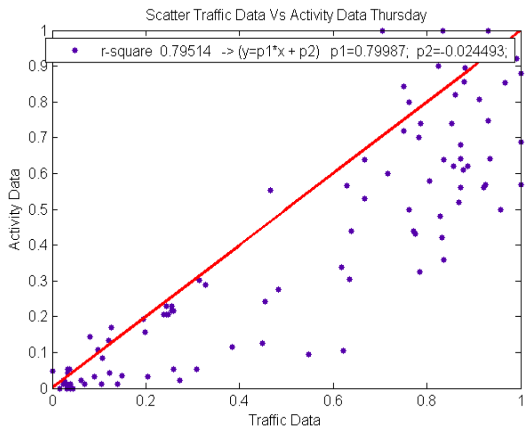
Figure 1(a) and 1(b) show a very similar trend, so using this function to obtain the target matrix for the DDE problem, the matrices used to determinate the Traffic Demand on Thursday and Wednesday are very similar, as confirmed by the scatterplot between the functions in figure 1(c). A demand estimation from the above traffic counts would therefore provide very similar results.





(b)





(c) *(d)*

Figure 2: (a) Aggregate plot of the observed activities for Wednesday; (b) Scatter Activity Data and Traffic Data on Wednesday; (c) Aggregate plot of the observed activities for Thursday; (d) Scatter Activity Data and Traffic Data on Thursday;

Figure 2 presents the differences between the activity pattern for Wednesday and Thursday obtained by the surveys. The particular trend in Figure 2(a) is related to the fact that on Wednesdays in Belgium the schools close sooner with respect to the other days. The Activity's Trend shows as the trip demand is very different for the two days. The scatter between the Activity Data Function and Traffic Data Functions (Figure 2(b) 2(c)) shows that traffic demand function not ever represent the demand trend, and also when the trend of the demand is similar (Figure 1(c)) there is a Bias between the two functions, that it is transferred to the seed matrix. On the other hand, also Activity Functions present biases, related for survey coverage; an evident gap in the respondents’ population is that trips originating and ending in the study areal are not included. It is so necessary to obtain a new function taking into account the Activity Function and correcting them using the aggregate information from the traffic count.

<u>Contribution to the existing literature:</u>

The discrepancy between traffic data and activity data may therefore be corrected by considering that travel patterns modeled during the early afternoon significantly differ.

Once we defined the appropriate Activity Function to relate to the Traffic Counts, it is possible to disaggregate the Activity Function observing each single component. In this way is also possible to take into account in the OD estimation spatial information, and not only temporal information. On a specific link is possible, for example, observe only the demand peak of the evening, this could be explained observing the activity in the specific area.

In the full paper we will show how demand estimation can be improved by separating seed matrices by activity and by associating a different functional relation to these activities in time. Further improvements are foreseen also considering that activity chains can be interpreted and used as constraints to the reproduced traffic patterns.

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