Transit Data 2019 Workshop and Symposium – Extended Abstract

A data-intensive software application for customer-centered transit planning

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Introduction

The widespread adoption of advanced information and communication technologies has led to a diversification of the urban transportation market. Ride-hailing services, bikeshare, progressively more autonomous vehicles, each enhanced with smartphone apps, are having a disruptive effect on public transit use. In addition, urban transportation authorities are placing increasing importance on developing public transit services that can offer a competitive alternative to the private automobile. In this context, it can be argued that the planning of transit service should be focused on providing an optimal experience for each transit user. Fortunately, new computing technologies and new data sources appear to offer the possibility of developing improved transit planning tools based on large volumes of detailed information on transit supply and demand (for example, see Anda et al., 2017 and Auld et al., 2016). This paper describes the development of one such tool – the Customer Impact Simulator (CIS): a schedule-based trip assignment model that uses large transit datasets, notably complete vehicle schedules, as input. The paper discusses the methodological foundations of the CIS, sources of data, the trip assignment algorithm, and finally some example results of simulation output. The final section offers some concluding remarks.

Methodology

In order to generate detailed results, especially those related to customer experience, the simulation must consider numerous objects. With respect to travel demand, the primary objects of interest are the passenger and the passenger trip. On the supply side, there are scheduled transit vehicle trips, transit stops, the road network, and the pedestrian network. These supply-related objects must be converted into a dynamic network that can be analysed by a schedule-based shortest-path algorithm. The algorithm generates a complete itinerary for each trip, including walking and transfer legs as well as each transit vehicle used. These results can be aggregated to the level of stops, street segments, route segments or entire routes over variable time periods with the objective of simulating, as completely as possible, the transit user's experience on an existing or proposed service scenario. Ideally, the simulation output is presented using effective visual techniques that transmit a clear message to the decision-maker, the customer, or the public.

Although this methodology is theoretically straightforward, its practical implementation presents numerous challenges, three of which are discussed in detail in this paper. First, transit demand data are often structured in the form of a time-sliced origin-destination matrix and an associated zone system which, in addition to undermining the precision of the network data and the shortest-path algorithm, can cause simulation times to increase significantly. Second, the size (in terms of bytes) of the input data and the output results requires the integration of powerful data management and analysis tools to permit seamless information flow into and out of the simulation environment. Third, the detailed network information describing the existing transit service and required for model calibration can be obtained from the transit operator's current service plan. However, the amount of available detail varies considerably for hypothetical service plans.

Sources of data

Transit planning data continues to evolve with information and communication technology. With respect to transit demand, to traditional sources of data such as census, travel survey and population synthesis have been added passive data sources obtained from smart cards, cellphones and mobile applications. On the supply side, standardized schedule formats for customer information (such as GTFS) and bus fleets equipped with AVL can provide data where planned operational schedules in structured electronic format are unavailable or insufficient. In large urban areas, these datasets are big.

The simulation algorithm

The simulation algorithm generates a point-to-point transit itinerary using complete existing or proposed vehicle schedules. Access and egress on foot are simulated using the pedestrian street network. The treatment of initial wait times, and the level of temporal precision of the shortest-path search, are parameters modifiable by the user. These parameters allow simulation precision to be exchanged for faster simulation times. The algorithm performs with reasonable speed even on very large networks when adequate memory and processor requirements are met.

Some results

The CIS tool generates three general types of results. The first type consists of accessibility measures that are independent of demand such as the area reachable from a single origin in a specified amount of time. The second type of results are the demand profiles and crowding levels at the stop, route segment and route level, by varying time periods. The third type of results are the detailed simulated paths of each traveller, which allow an assessment of the impacts of service changes on customers. Some visual and numerical examples of each type of result are presented based on an application of the CIS to the metropolitan Los Angeles region.

Conclusions and prospects

New technologies and large, detailed datasets offer exciting possibilities for better transit planning, but the construction, maintenance and operation of complex simulation environments is challenging. Future work will focus on addressing the practical challenges to implementation discussed above. It is hoped that the CIS tool, applied to multiple case-studies. will further demonstrate the utility of a data-intensive, customer-oriented approach to transit planning within the rapidly evolving domain of urban transportation.

References

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