DRISI
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Research Results

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Project Title:
Modeling e-hailing and car-pooling services in a coupled morning-evening commute framework

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Modeling E-hailing And Car-pooling Services In A Coupled Morning-evening Commute Framework

Leverage previous study on e-hailing and ridesharing to develop a general equilibrium model that captures the complex interactions between solo-driving, e-hailing, car-pooling, and transit

WHAT WAS THE NEED?

There are significant challenges in modeling the multi-class, sometimes competing and sometimes cooperating modes of travel in a single modeling framework. These challenges include how to represent these various modes and their connections in a unified and potentially layered transportation network, how to account for the various "cost" factors of each service such as waiting time for e-hailing and car-pooling, how to model these factors and the competition between different modes or mode combinations in a general network equilibrium, and how to link morning and evening commute in such a general equilibrium model such that both the essential features of this complex system are captured and it is still mathematically tractable.

WHAT WAS OUR GOAL?

This project aims to understand the impact of the new mobility modes on traffic congestion, travelers' behavior of mode choices, added vehicle miles driven by empty service cars, and efficiency of the overall urban transportation systems for travelers.

WHAT DID WE DO?

The researchers extended the development of a broad traffic equilibrium model to address the fusion of the recent emergent industry of e-hailing service providers and shared rides with the traditional transportation modes of public transit and solo-driving. Because of the options to switch modes between the morning and evening commute, and because the choice of a mode in the morning depends on the choice of the mode in the evening, the researchers explored different approaches to model the home-work-home travel.

WHAT WAS THE OUTCOME?

The research proved that an equilibrium exists for the proposed model and showed that when the model reaches an equilibrium, (1) the morning (evening) commute also reaches an equilibrium; (2) if travelers' mode choice is fxed, the morning (evening) commute is equivalent to a traditional traffic equilibrium problem; (3) travelers are rational to mode choice, which means that no traveler will choose a more expensive travel mode combination. Furthermore, it provided the conditions under which travelers' mode choice would be unique.

The proposed model is validated in two networks: a small network and the Sioux-Falls network. The results show that the proposed coupled morning-evening model is effective in capturing the mode switches between morning and evening, which eventually leads to better system performance (e.g., number of drivers, total Vechile Miles Traveled (VMT)) compared with a decoupled morning (evening) commute model. For example, in the Sioux-Falls network, the coupled model produces 24.2% fewer drivers and 8.4% less VMT in the system compared with the decoupled model when the inconvenience cost due to ridesharing is higher during the evening commute than in the morning commute.

Also, the coupled model can capture the behavior of travelers' capability to switch to e-hailing in the evening commute when ridesharing in the morning commute. A decoupled model cannot capture this effect and most likely will predict that the traveler will drive to work.

WHAT IS THE BENEFIT?

This project addresses several of Caltrans' goals in its strategic plan: efficiency, sustainability, and accommodating and supporting innovative mobility technologies. The potential of integrating e-hailing, car-pooling, and transit services seamlessly and more effectively could reduce solo-driving, and consequently lessen traffic demand, congestion, and VMT. A better understanding of this integration can also lead to better deployment of high-occupancy vehicle lanes and car-pool pick-up and drop-off locations, to just name a few components specifications.