Cost-Sharing Mechanisms for Ride-Sharing

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Project Objective

The goal of this research was to develop cost-sharing mechanisms for ride-sharing providers to determine suitable prices for passengers sharing a trip.

Problem Statement

Congestion in the United States continues to rise, stressing vital infrastructure, causing delayed shipments, late employees, and countless other problems. The increased adoption of dynamic cost-sharing transportation systems such as ride-sharing could help alleviate some of this traffic and its related nuisances.

A set of technologies focusing on cost-sharing transportation systems have recently emerged. While these new cost-sharing transportation systems are not the complete answer to congestion nationwide, their ability to augment existing public infrastructure, such as mass transit, could help to solve many congestion related problems in urban areas like Los Angeles. Transportation planners today do not have effective tools or means, for example, to quantify the impact of incentive structures for ride-sharing.

Research Methodology

This research provides a method to determine how to allocate the cost savings in ride-sharing. We first reviewed the scientific literature on the mechanisms for routing problems. Through this process, we identified desirable properties in the context of ride-sharing where the drivers have limited time on route and have their own destinations. Based on the identified desirable properties, we then developed a cost-sharing mechanism framework that allows the combination of different mechanisms applied to different cost components. We built a cost-sharing mechanism for the static scenario (passengers' requests are known before the driver leaves their origin) based on the previously developed Proportional Online Cost Sharing (POCS) mechanism, which was developed for shuttle services and made it applicable for ridesharing services, where the driver also has a desired destination instead of just being a professional driver. We extended our mechanism design into scenarios where in-vehicle time is taken into consideration and where passengers may dynamically submit requests during the ride-sharing operation

The Los Angeles regions was used as the basis for validating the models. This region was ideally suited, because there are dedicated carpool lanes in the freeway network where congestion pricing is employed where ridesharing vehicles can travel for free (e.g., Interstate-110). In addition, researchers at University of Southern California developed the Archived Data Management System (ADMS) that collected, archived, and integrated a variety of transportation datasets from Los Angeles, Orange, San Bernardino, Riverside, and Ventura counties. These data sources gave a detailed space and time estimate of demand by time of day and trip type to develop different operating scenarios for analysis.

Results

We tested the cost-sharing mechanisms on a simulation model using traffic data sets generated from sensors. We selected a region near Downtown Los Angeles that includes 33 sensors on 7 freeways: I-5, I-10, I-105, I-110, I-710, SR-60, and SR-101 (see Figure 1).

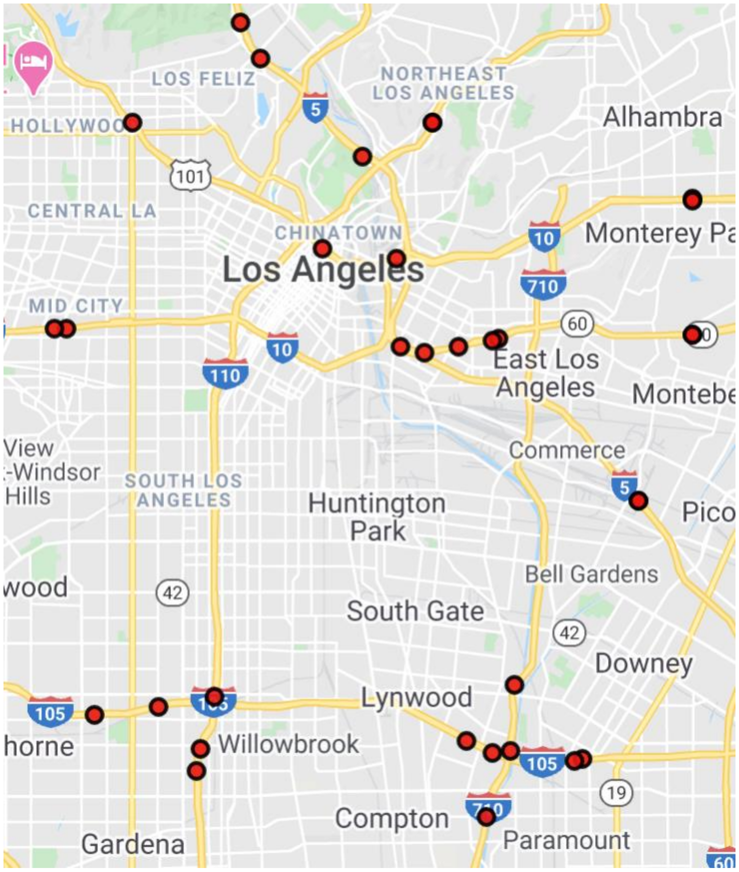

Figure 1: Map of Sensors

We varied two ratios, the ratio of Rideshare Drivers over Potential Passengers (D/P) and the ratio of the Actual Travel Time over the Direct Travel Time for the Driver (A/D). The simulation results showed that the cost sharing mechanism was able to find a feasible matching of passengers to drivers 56% of the time when the D/P ratio was 0.3 and 78% of the time when the D/P ratio was 0.5 when the A/D ratio equals 1.5. When the A/D ratio increases to 2, the simulation results showed that the cost sharing mechanism was able to find a feasible matching of passengers to drivers 75% of the time when the D/P ratio was 0.3 and 95% of the time when the D/P ratio was 0.5. These results illustrate the importance of having a sufficient number of rideshare drivers who have some flexibility on their travel time on the ability to match passengers to drivers.