DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Modal

AUGUST 2021

Project Title:
Public Transit and Bikesharing/ Scooter Sharing Interactions

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Improved Pathing for Rideshare

Develop a non-myopic path-finding algorithm that considers two criteria, namely, travel time and proximity to future demand.

WHAT WAS THE NEED?

Shared-ride mobility-on-demand (MOD) services offered by transit agencies (e.g. flexible, demand-adaptive, and demand-responsive transit) and private companies (e.g. Uber Pool, Lyft Line, microtransit) have the potential to provide high-quality, convenient, and affordable on-demand mobility service to individual travelers, while simultaneously obtaining the societal benefits of decreased vehicle miles traveled, congestion, and vehicle emissions through increased vehicle occupancies. However, for shared-ride MOD services to capture these societal and individual mobility benefits, they need to be operated efficiently.

In practice, and in the academic literature, fleet controllers assign shared-ride vehicles (like non-shared-ride vehicles) to the shortest network path, in terms of travel time, between pickup and drop-off locations in their schedules. While this strategy/policy is intuitive, it is also myopic given the nature of shared-ride on-demand service and the (high) likelihood new users will request service as vehicles traverse network paths between pickup and drop-off locations. A non-myopic approach would anticipate the possibility of new requests and consider the proximity of network paths to future user requests (i.e. demand) when assigning shared-ride vehicles to network paths.

WHAT WAS OUR GOAL?

The goal of this research project is to improve the operational efficiency of shared-ride mobility-on-demand services (SRMoDS). SRMoDS ranging from UberPool to micro-transit have the potential to provide travelers mobility benefits that are comparable to existing ride-hailing services without shared rides such as UberX, but at a lower cost and with fewer harmful externalities.

WHAT DID WE DO?

The Preliminary Investigation (PI) hypothesis is that the consideration of proximity of network paths to future demand in the controller's objective function will increase shared-ride opportunities and prevent some shared-ride vehicle detours from low-demand, high-speed areas back to high-demand, lower speed areas to pick up new requests. This should subsequently improve service quality, decrease operational costs, and decrease required fleet sizes for shared-ride MOD services.

To meet the project's objective, and test the PI's hypothesis, the research team plans to:

- Conceptualize the non-myopic pathfinding of shared-ride vehicles and identify relevant parameters;
- Develop a modeling framework and mathematical model for static and dynamic bi-criterion best-path problem for shared-ride vehicles;
- Create a robust solution algorithm to non-myopically assign individual shared-ride vehicles to network paths, considering travel time and proximity to expected demand;
- Validate and test the solution algorithm and mathematical models on a variety of test networks and under various demand scenarios.

The main project deliverables include a final report and computer code, the specifics of the deliverables are provided in Section III of the proposal. The final report will include a synthesis of the related literature, a conceptual framework for the operational problem, a clear delineation of the research problems/questions, a mathematical programming model for the non-myopic path-finding problem for shared-ride vehicles considering travel time and proximity to demand.

It will also include a solution algorithm to solve this mathematical programming model, an extensive computational analysis to test and validate the model and solution algorithm, and a discussion of the implications of the computational results.

WHAT WAS THE OUTCOME?

This research provides evidence that bi-criteria pathfinding can improve the operational effectiveness of SRMoDS and likely other ride-sharing services. Simulation results indicate that bi-criteria pathfinding can reduce both waiting time and in-vehicle travel time for travelers. However, the average improvement is relatively small and there is pretty large variance in regard to the performance gap between bi-criteria and shortest path approaches.

The study also finds that the effectiveness of bi-criteria pathfinding is determined by multiple factors, including the number of vehicles, the number of requests, network size, bi-criteria conditions, and reward coefficients. Simulation results indicate that the bi-criteria pathfinding approach performs best with a slight under- or over-supply of vehicles relative to demand. The study also finds that bi-criteria pathfinding works best when vehicles are empty or only have one remaining drop-off task and no pickup tasks.

WHAT IS THE BENEFIT?

The operational benefits found in this study are relatively small, future research efforts related to tuning hyperparameters should allow bi-criteria pathfinding to significantly improve SRMoDS.

LEARN MORE

https://www.metrans.org/research/non-myopic-path-finding-for-shared-ride-vehicles-a-bi-criteria-best-path-approach-considering-travel-time-and-proximity-to-demand

IMAGE

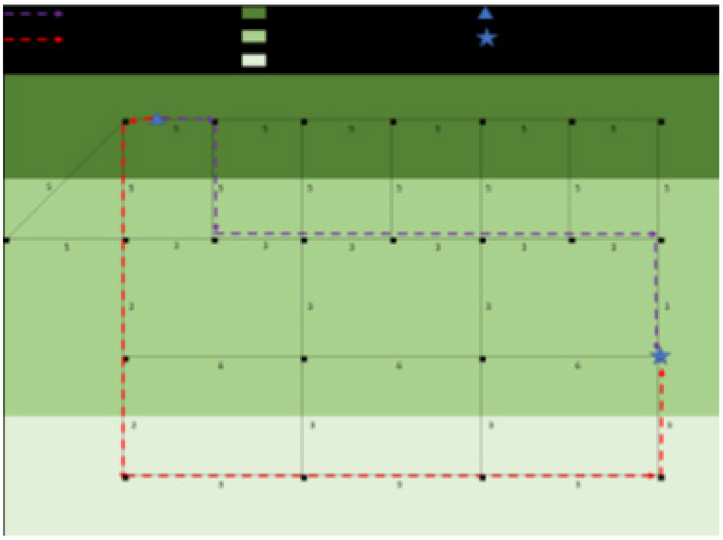

Image 1: Paths for myopic (red) and non-myopic (purple) strategies

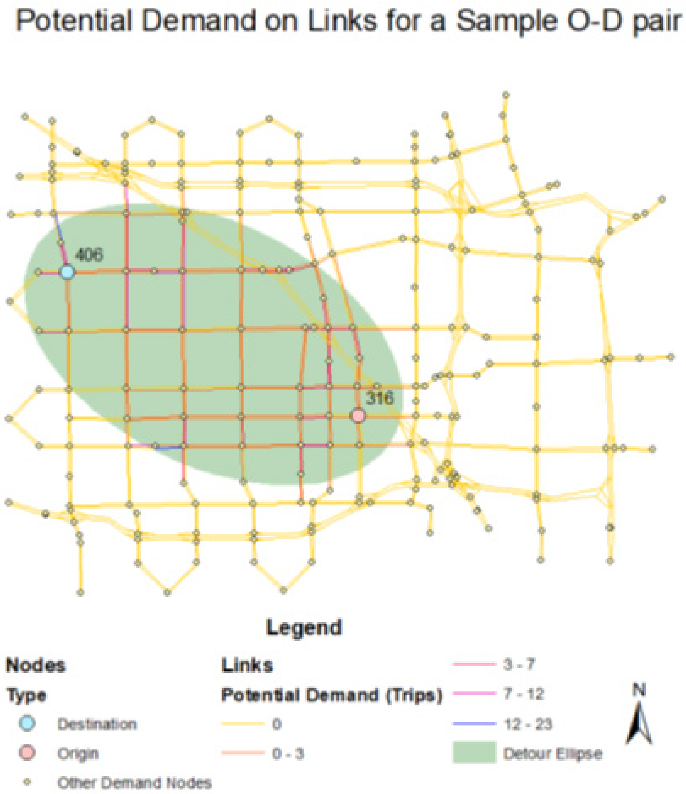

Image 2: Illustrative Example of Calculating Potential Demand on Links