DRISI
Caltrans Division of Research, Innovation and System Information

Research Notes

Non-Myopic Path-Finding for Shared-Ride Vehicles: A Bi-Criterion Best-Path Approach Considering Travel Time and Proximity to Demand

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

Modal

MAY 2020

Project Title:
Transit Research

Task Number: 3426

Start Date: January 1, 2020

Completion Date: December 31, 2021

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WHAT IS 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 achieving the societal benefits of decreased vehicle miles traveled (VMT), 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 ARE WE DOING?

The Principle Investigators (PI's) 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 and navigate vehicles 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 path-finding 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 final report will be written detailing all the tasks that were completed in this research project. This report will also include the practical implications and potential applications of the results. The computer code will be a copy of the mathematical programming formulation as well as the pseudo-code for the model solution algorithm.

WHAT IS OUR GOAL?

The goal of the research is to support the efficient operation of shared-ride MOD services to enhance mobility via developing a non-myopic algorithm to assign individual shared-ride vehicles to network paths considering proximity to future demand in addition to travel time.

WHAT IS THE BENEFIT?

The outcome of this research should lead to an improvement in the operational efficiency of shared-ride MOD services. The improvement will come through a non-myopic path-finding algorithm that considers two criteria, namely, travel time and proximity to future demand. Moreover, an important outcome of this research will be the conceptualization of the bi-criterion best-path problem for shared-ride vehicles, in addition to the solution algorithm. The PI believes this preliminary research on path-finding for individual shared-ride vehicles will not only improve operational efficiency of shared-ride MOD services and enhance mobility in metropolitan areas in California, it will motivate important future transportation research that will attract funding from a variety of sources.

If the modeling approach and subsequent algorithms are successful, the research would likely have a significant impact on the usage of roadways in California. As mentioned previously, depending on the market share of mobility-on-demand services in the future (with and/or without automated vehicles), the algorithms developed in this study could significantly impact the usage of different roadway types (e.g. highways vs. arterials). The research also has the potential to spur the growth of sharing rides in mobility-on-demand services, which could significantly decrease VMT in the state of California without decreasing person miles traveled or economic output.

WHAT IS THE PROGRESS TO DATE?

January 1, 2020 – March 31, 2020

Due to encumbrance delays, the start of the project will be April 1, 2020.