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.

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.