UTC - Implications of Information Structure in Control of Urban Traffic Networks - FAST Act - PSR 017

Study performance of traffic networks under various information structures (i.e. sparse interconnection of control/decision and sensor points).

WHAT IS THE NEED?

Rapid advancements in technology have facilitated a tremendous increase in the number of control/decision and sensor points in urban traffic networks, ranging from an individual driver carrying a smart phone to ramp metering, to a city-scale traffic control center.

Due to the large volume of data generation, it is computationally and arguably, even technologically infeasible, to inter-connect all the points to each other for real-time applications. Therefore, there is a need to study performance of traffic networks under various information structures (i.e. sparse interconnection of control/decision and sensor points).

WHAT ARE WE DOING?

The research team at the University of Southern California (USC) will analyze optimal control of traffic flow over networks using a combination of variable speed limit, ramp meter, lane-changing, and routing control. They will develop the foundations for a framework to design closed-loop control under given information structures. The emphasis will be on computational tractability of performance gap with respect to centralized control.

The research team will then study optimal information design to influence route choice decisions of drivers in dynamic environments. Specifically, they will adopt the framework of
algorithmic persuasion, under which the system planner can exploit information asymmetry about the knowledge of the real-time state of the network to release alternate routes to the drivers to optimize the social objective.

The study of algorithmic persuasion is very recent, and more so, the existing work implicitly assumes the drivers to evaluate the incentive compliant nature of the recommendations from the system planner only asymptotically. Researchers will address these shortcomings to develop foundations for algorithmic persuasion in routing. The methodological contributions will be supplemented with case studies using traffic data from corridors in the Los Angeles area, and with simulation case studies utilizing the Verkehr In Städten – SIMulationsmodell microscopic multi-modal traffic flow simulation tool.

WHAT IS OUR GOAL?

The goal is to develop algorithms for distributed control of urban traffic networks and for route recommendation mechanisms and illustrate their impact through simulation case studies. The findings of this research will be published in respected transportation and control journals and will be presented at relevant conferences and workshops.

WHAT IS THE BENEFIT?

California has several congested urban areas, as well as a vibrant technology culture in the mobility domain. It is imperative to develop the appropriate basic research and case studies to connect the emerging data science and cloud computing technologies with classical control mechanisms such as ramp meter, variable speed limit and route recommendation mechanisms. While the case studies will be developed in the context of California, the basic research will be universally applicable. The results of this research, if/when implemented, could help in providing reliable real-time alternate routing to drivers when there is traffic congestion on the California roads.

WHAT IS THE PROGRESS TO DATE?

Researchers developed computational algorithms for designing optimal public and private signals (i.e., randomized obedient recommendations) for arbitrary networks and for arbitrary link delay functions. They characterized computational complexity of algorithms in terms of network structure, link delay functions, and uncertainties. They also implemented the algorithms in USC’s high-performance computing system.

In the simulations & analysis, researchers generalized the framework of distributed control for freeway networks to include the possibility of off-line centralized coordination.