Two-Way Transit Signal Priority for Optimizing Transit Reliability and Speed

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MOTIVATION

Transit Signal Priority (TSP)

- Effective in reducing signal delays
- Does not guarantee reliability improvement

Transit Reliability and Speed

- Key performance indicators for transit agencies and users
- Transit services are vulnerable to variability and delays
- No strategies can adaptively optimize reliability and speed simultaneously

Multiple Requests from Opposite Directions

- Commonly used first-come-first-served logic does consider performance in both directions

OBJECTIVE

Dual-Objective TSP

Adaptively optimize reliability (i.e., headway regularity) and reduce signal delays simultaneously

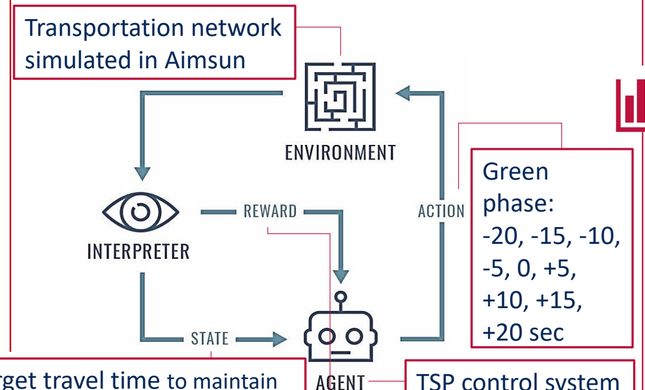
Coordination of Opposite Directions

Develop an algorithm to coordinate TSP in opposite directions of the same intersection based on real-time bus performance

MODEL FORMULATION

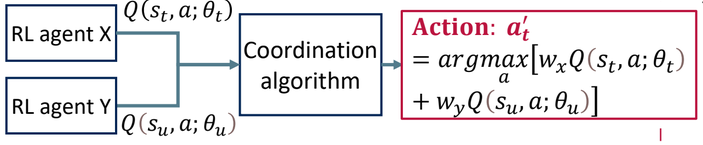
One-Way DRL Agent

- Model-free deep reinforcement learning
- Efficient for large state space



Two-Way Coordination Algorithm

- Coordinates two DRL agents when both directions require TSP in the same signal cycle to optimize reliability and speed for both directions based on weighted Q-values



SIMULATION

Training and Testing

- Microsimulation using Aimsun Next connected with external DRL program and the coordination algorithm; trained and tested at a major intersection in Toronto, Canada

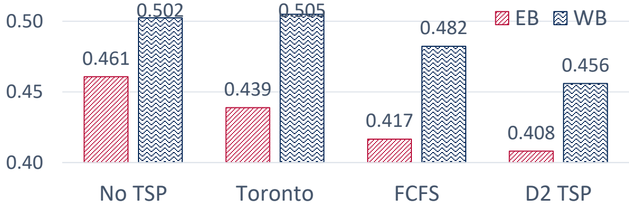
RESULTS

Base Scenarios

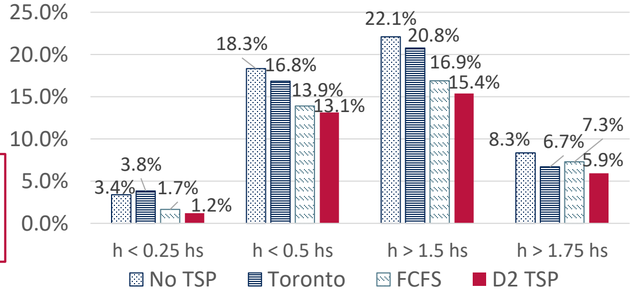
- No TSP, TSP in field (Toronto TSP), DRL + first-come-first-served logic (FCFS TSP)

Comparison of Performance

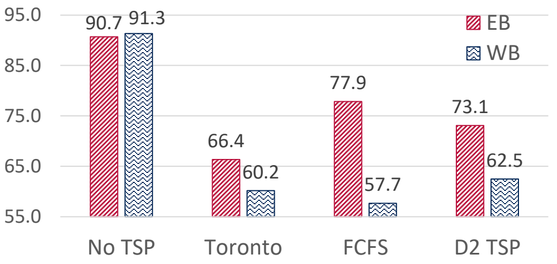
- Coefficient of variation of headway



- Extreme headways



- Travel time



CONCLUSIONS

The Proposed Two-Way TSP (D2 TSP)

- Generates the best headway performance in both directions: effective in reducing headway variability and % of extreme headways
- Brings noticeable reduction in travel time compared with "No TSP"

FUTURE WORK

- Coordinated TSP systems to enhance the benefit on transit reliability and speed at the route level
- Use connected vehicle technologies for detection and communication
- Integrate TSP design with other route elements