OPTIMAL DISPATCHING AND REPOSITIONING STRATEGY FOR AUTONOMOUS TAXI USING REINFORCEMENT LEARNING

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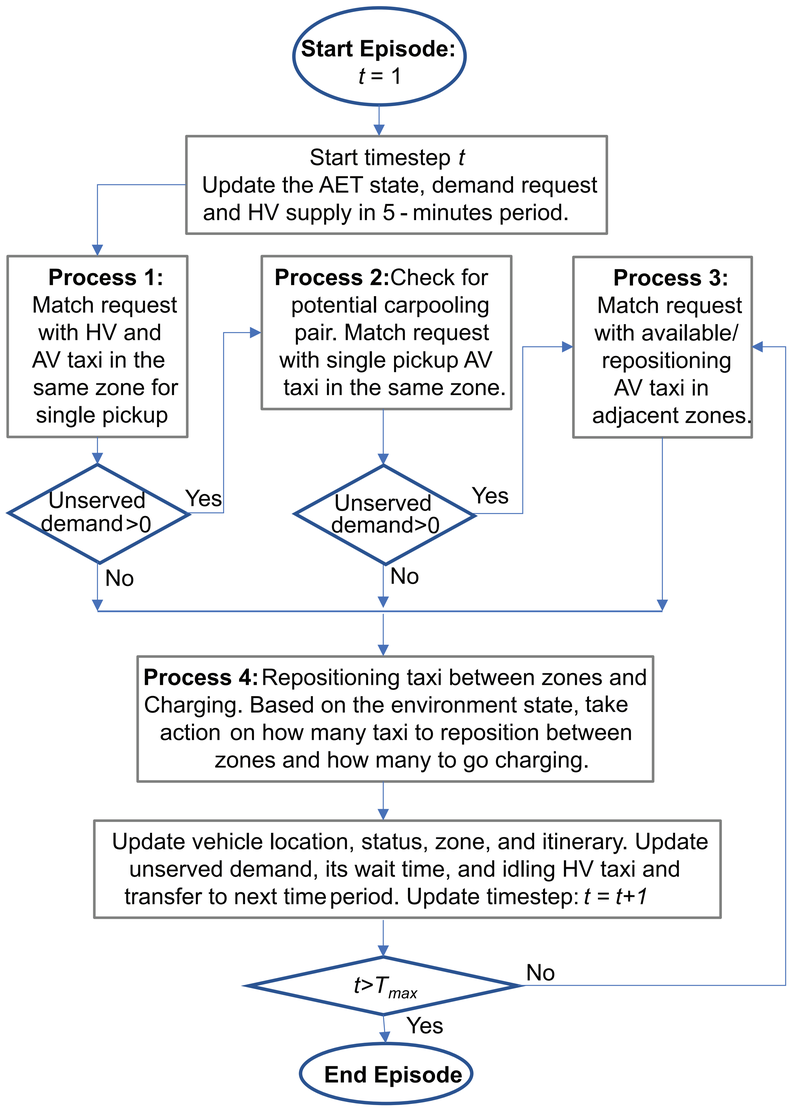
INTRODUCTION

- Transportation Network Companies (TNC) is leveraging technology and connectivity to provide a more efficient taxi service with example such as Uber and Lyft.
- However, the system is hindered by the spatial and temporal imbalance between supply and demand despite TNC's economic incentives such as surge pricing.
- Autonomous Electric Taxi (AET) and smart repositioning of taxi can solve this supply and demand imbalance.
- With the near future level of AV integration, TNC is likely to include human-driven vehicle (HV) in the system and AV can only traverse freely on selected links.
- The objective of this research is to "develop a framework to optimally dispatch both HV and AET, reposition, and recharge AET with the objective of minimizing the customer wait time, cancellation penalty, and AET's operational cost".

METHODOLOGY



METHODOLOGY

- Process 4 uses RL to reposition and recharge AET.
- Given a state, the agent will take action, receive a reward, and transfer to the next state.
- The goal is to maximize the total cumulative reward

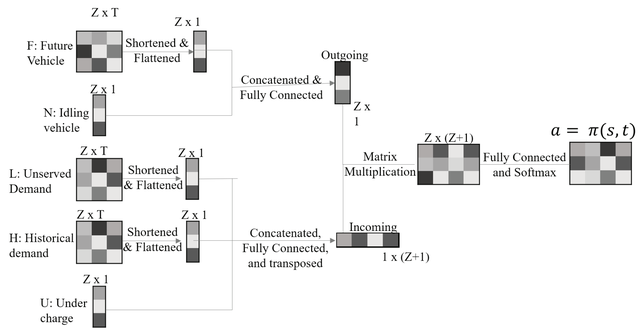


Figure 1. Policy Function a Neural Network

CASE STUDY

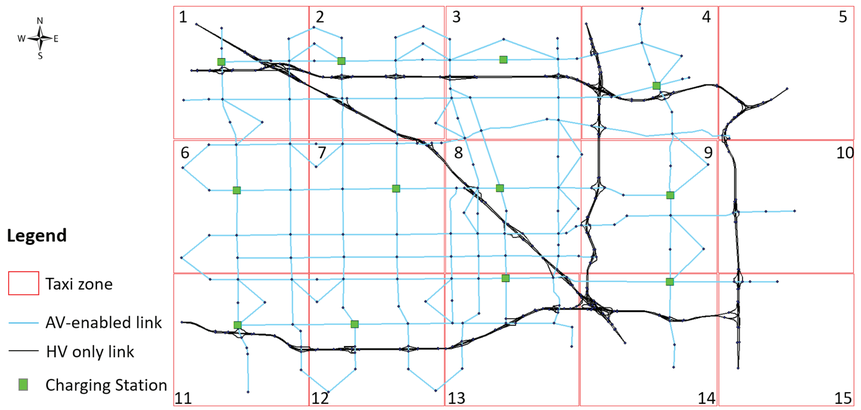


Figure 2. Anaheim Road Network, Taxi Zone, and AV facilities

RESULT

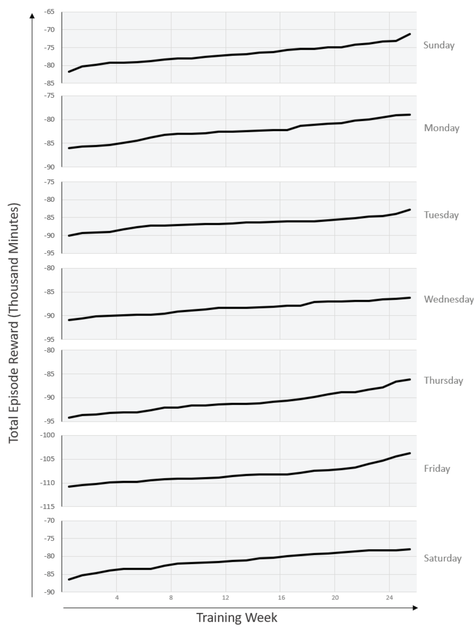


Figure 3. RL Training Performance

- We first examine the training of the framework. Then we look at the repositioning decision by calculating the incoming vehicle 30 mins prior to the afternoon peak hour.

Repositioning Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	1	1	0	0	0	0	1	0	2	0	1	1	0	0
3	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0
4	0	0	0	1	0	1	2	0	0	1	2	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	2	1	0	0	1	2	2	2	0	0	0	0	2	0	0
7	2	1	0	0	1	0	1	0	0	0	0	0	0	0	0
8	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0
9	0	1	0	0	1	1	2	0	1	1	1	0	0	0	0
10	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0
11	1	0	1	0	0	1	0	0	0	1	0	1	0	0	0
12	0	1	1	0	1	0	1	0	1	0	0	1	0	1	0
13	1	1	0	0	1	1	0	0	0	2	0	0	1	0	0
14	1	1	1	2	1	0	0	0	0	0	0	0	0	1	1
15	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0

Total Incoming Vehicle

10	7	5	5	7	6	10	3	3	7	5	4	6	2	1

Demand

16	5	7	2	5	2	5	3	2	8	6	3	4	1	2

Figure 4. Repositioning Decision during afternoon peak hour

RESULT (CONT.)

- We then compare our AET framework with a Manual Allocation (MA) strategy to validate AET's performance. MA will match taxi with the closest customer request and there is no repositioning. The taxi is charged when its battery is lower than a certain threshold.

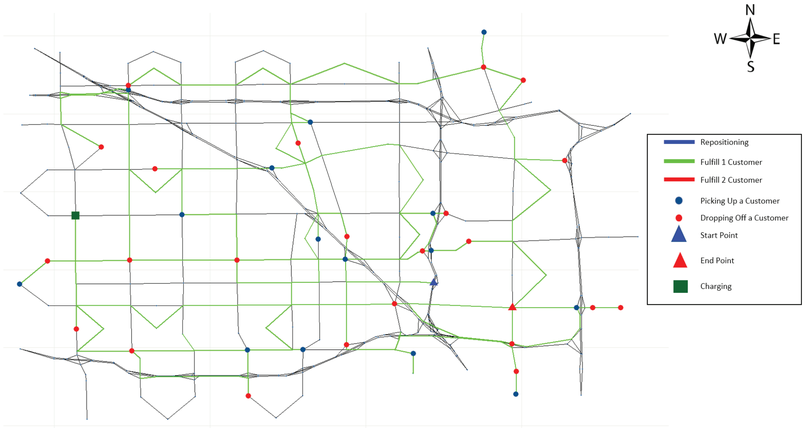


Figure 5. Manual Allocation Taxi's Itinerary

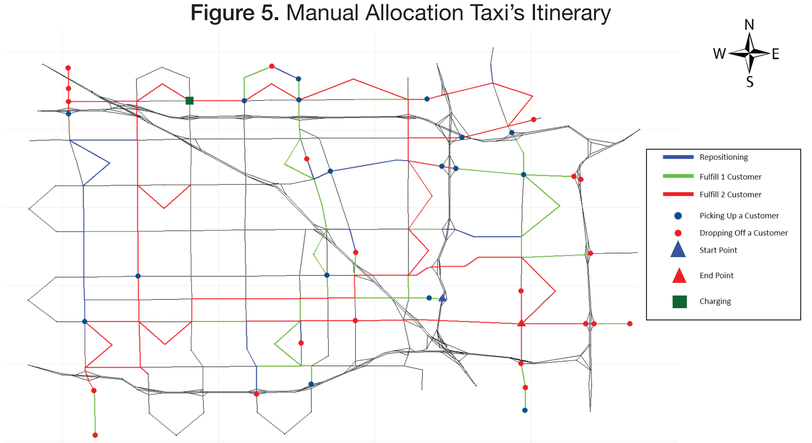


Figure 6. AET's Itinerary

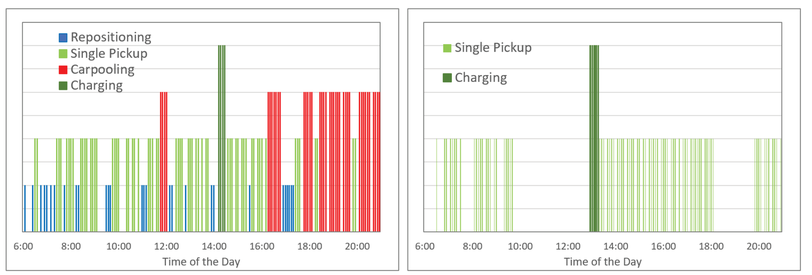


Figure 7. Manuall Allocation and AET "A Day in the Life"

CONCLUSION

- This research develops a framework to optimally dispatch and reposition taxi to address the spatial and temporal imbalance between supply and demand.
- Compare to MA strategy, the framework can reduce the wait time and number of cancelled trips by up to 75% and 73% respectively.
- For future avenues of this research, each operating days are considered separately and the taxi starting points are the same and thus, these elements should be included to better reflect the real-world scenario