ABSTRACT

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Thesis title: **Reinforcement learning based car-following model for stop-and-go traffic**

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Car-following is one of the most frequently occurring scenarios in driving cycles and also forms a critical component of autonomous driving vehicles. Since the early 1950s, there have been numerous advancements in car-following models that have successfully predicted human driver behavior. With the advancement of autonomous vehicle technology, the need for models that outperform human drivers has emerged, leading to the development of Reinforcement Learning (RL) based car-following models. Various related studies have demonstrated that RL-based models can outperform humans as well as traditional and other machine learning-based data-driven models. However, these studies focused mostly on highway scenarios, whereas urban traffic dynamics are significantly different from highways. The current study aims to develop an RL-based car-following model for stop-and-go traffic.

The proposed methodology involves development of suitable reward functions focusing on safety, efficiency, and comfort of the drivers, alongside a collision avoidance strategy to minimize collision risks. State-of-the art RL models developed for highway traffic scenarios uses time headway based rewards for efficiency, which is not applicable for stop-and-go traffic when the vehicle speed approaches zero. Therefore, this study proposes space headway-based efficiency reward function incorporating the concept of the desired minimum gap, used in some traditional car-following

models. Along with this efficiency reward, the model also uses safety reward based on Time-To-Collision (TTC) and comfort reward based on jerk.

Due to limited availability of high quality real-world trajectory dataset for stop-and-go-traffic, this study develops and tests the proposed model with a popular traffic simulation software, VISSIM. The proposed model has been compared with the simulated data using the cumulative distribution function (CDF) curves for TTC, space headway, and jerk to determine the overall efficacy of the proposed model. The CDF curves show that the model-based action can help to maintain higher TTC while keeping lower space headway along with reasonable jerk values. Further, visualizations of sample car-following events shows the advantages and limitations of both proposed RL-model and simulated data. These insights can help to develop a RL-based comprehensive car-following model which can be applicable for different traffic scenarios, with the overall objective of safer and efficient traffic movement.