Grant Deliverables and Reporting Requirements for UTC Grants

UTC Project Information	
Project Title	Design autonomous vehicle behaviors in heterogeneous traffic flow
University	University of California Davis
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Funding Source(s) and Amounts Provided (by each agency or organization)	USDOT: $75,867 UCD: $38,106
Total Project Cost	$113,973
Agency ID or Contract Number	Sponsor Source: Federal Government CFDA #: 20.701 Agreement ID: 69A3551747119
Start and End Dates	Start date: 04/01/2021 End date: 03/31/2022
Brief Description of Research Project	The benefits of autonomous vehicles (AVs) not only depend on the maturity of technologies, but also how AVs behave and interact with their peers and human-driven vehicles (HVs). Similar to many other systems, individual and collective dynamics of traffic flow are not always aligned with each other (for instance, aggressive driving may benefit an individual driver but disrupts the overall traffic). It is therefore imperative to consider behavior design for AVs such that the benefits of AVs can be realized at both individual and collective levels, even absent of centralized control. Behavior protocols for AVs will define their "driving styles", in terms of information perception, utility, and opportunisticity. One possibility is letting all AVs be "human-like", as did in existing literature. This research will explore more sophisticated behavior designs based on system principles and data. We will explore two approaches. The first approach is game-theoretic. In this approach, we start from defining agent utilities and casts interactions of heterogeneous agents as a spatial game. When a potential function for this game can be constructed, we

	may prove the existence of its equilibria, derive conditions that lead to the desirable equilibria, and design AV behavior protocols based on these characterizations. From models of similar nature (known as Schelling's models, which reproduce residential segregation), we anticipate that with proper behavior protocols AVs can spontaneously form into platoons, even without centralized controls. The second approach is data-driven, leveraging deep reinforcement learning and big traffic data. In this approach, we will train AVs as reinforcement learning (RL) agents from real-world trajectory data. Behavioral protocols are then obtained as the RL agents are endowed with reward functions of different structures. We will identify the reward structures that best balance the individual and system goals and quantify the corresponding effects through simulations.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	
Impacts/Benefits of Implementation (actual, not anticipated)	
Web Links • Reports • Project Website	http://ctech.cee.cornell.edu/final-project-reports/