Learning how to price for rebalancing the electric ride hailing fleets

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Abstract

The undeniable growth in popularity of both the services offered by the ride-hailing companies and the electric vehicles (EVs) implies that charging management of the ride-hailing vehicles will likely become a significant part of the ride-hailing company's operation in the near future. Motivated by this, we study a scenario in which in order to avoid overcrowded charging stations, a central authority, e.g., the government, will design pricing policies to incentivize the vehicles to spread out among the charging stations, in a setting where several ride-hailing companies compete about the resources. Because the companies share the charging infrastructure, they inherently compete to minimize their expected total queuing times at the charging stations allowing for a game theoretical analysis of the problem. From the perspective of Stackelberg and Inverse Stackelberg games we analyze different pricing mechanisms for the government that guarantee existence of a Nash equilibrium of the game played between the ride-hailing companies. We compare their performance in a case study based on taxi data from the city of Shenzhen and also show how the systems behave in terms of robustness with respect to the disclosed information provided by the ride hailing companies. Finally, as a part of the ongoing research, we propose a reinforcement learning setup in which the government is supposed to learn how to set the prices in accordance with a Stackelberg game.

Keywords

Stackelberg game, Inverse Stackelberg game, Electric vehicle charging