A Bi-level Approach for Vehicle Relocating in Mobility on-Demand systems

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Abstract

The imbalance between vehicle supply and customer demand has been a long-standing challenge for Mobility on-Demand systems wherein optimal relocation of idle vehicles to high-demand regions can facilitate rebalance of demand and supply and thus enhance the efficiency and profit of the system. However, due to the excessive computation complexity, link-node formulation and grid-based formulation may suffer from the bottleneck state of locally dithering in low-demand scenarios or over-supply regions. Therefore, we propose a bi-level rebalancing scheme to escape the dithering and counter the spatial-temporal imbalance.The urban area is partitioned into several subregions. For the upper level, the number of desired vehicles in each subregion and cross-boundary is modeled under the formulation of a stochastic programming problem and solved by the Approximate Dynamic Programming (ADP) algorithm. For the lower level, a Voronoi-based coverage control algorithm can be implemented efficiently on each vehicle leveraging local information to obtain the position guidance. Our algorithm is evaluated on a simulator modeled the real road network of Shenzhen, China. Simulation results demonstrate that the total profit and service rate can be enhanced compared to various other policies.

Keywords

Vehicle relocating/rebalancing, Bi-level control, Approximate Dynamic Programming, Coverage control, Stochastic optimization