基于排队网络的共享单车坏车运维建模与优化

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【摘要】运行过程中不断产生的坏车是当前共享单车运营面临的一个重要问题。研究针对坏车进行的回收、维修和投放过程怎样影响系统、如何解决相应的决策问题具有重要意义。本文考虑共享单车批量回收、集中维修和批量投放的运行特点，构建封闭排队网络模型，基于连续时间马尔可夫过程的长程稳态和蒙特卡洛仿真方法分析共享单车系统的运维过程对系统性能表现的影响。进一步，在可分配资源有限的约束下，决策维修能力和对应回收和投放的运载能力之间的最优配置。针对解空间有限、离散的特征，结合Ranking and Selection算法，以最小化服务顾客的损失率为目标进行决策。研究发现，提升维修和运载车的运行速率或数量均可以改善系统性能表现，但存在边际递减效应。当系统整体运行能力有限时，增加运载车能更有效地改善系统表现。本文所采用的算法可以有效地选择出最优或接近最优的系统设置。

关键词：共享单车；坏车运维；排队网络

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Maintainance analysis of Sharing-Bike Based on Queueing Network

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【Abstract】The operation and maintenance of the broken car in the shared bicycle system mainly includes three processes: recollecting, repairing and releasing. With the operating characteristics of batch recycling, centralized maintenance and batch delivery considered, a queuing network model

is constructed. and calculate the system performance parameters through the state transition equation and simulation of the Markov process to study the system. Then determine the allocation of resources in the system between the maintenance center and the recovery and release of vehicles, under the constraint of limited total resources. In view of the limited and discrete features of the solution space, we adopt a Ranking and Selection algorithm, to choose the optimal or near optimal setting with the goal of minimizing the loss rate of customers. We have found that increasing the operating speed or number of maintenance and delivery vehicles can improve system performance, but there is a marginal diminishing effect. When the overall operating capacity of the system is limited, adding trucks can more effectively improve system performance. When the gap between maintenance and delivery capabilities is small, the system's service capabilities are stronger. At last, we demonstrate the validation that algorithm adopted in this paper can effectively select a good system arrangement.

Key words: Sharing Bike；Maintainance；Queueing Network；Simulation