Matching Queues, Flexibility and Incentives

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In call centers with cross-trained service agents and other queueing-control systems whose servers can serve different subsets of job types, it is known that throughput is improved by reserving capacity from more flexible agents and preferentially dispatching jobs to less flexible agents when possible. This, however, critically assumes that the subset of demand serviceable by an agent is observed by the queueing control system.

We consider whether reserving capacity is similarly beneficial in ridesharing platforms like Uber in which drivers customize the subset of destinations toward which they are willing to take trips. This customization allows drivers to earn money while driving home or to a social obligation, potentially providing substantial benefit over dispatches absent such customization. However, because drivers report their availability over destinations strategically based on private information, reserving capacity from flexible drivers is substantially more challenging, especially if there are regulatory or operational constraints. Indeed, reserving capacity in a naive way can hurt flexible drivers’ earnings per hour and lead them to under-report the set of destinations they can serve, actually degrading throughput.

We study the challenge of non-monetary capacity reservation in a simple stylized model of ridesharing dispatch. In this model, \( k \) subsets of inflexible drivers are available only to serve one of \( k \) rider destinations near to where they live or have other personal obligations. The remaining drivers are flexible and can travel to any destination. We focus on mechanisms that do not provide any additional monetary incentives. This focus arises from limits on how a trip’s destination can influence its price and from the requirement that a trip’s price not depend on the identity of the participant performing it.

We first confirm that using the optimal queuing control strategy from the non-strategic setting can indeed degrade throughput in a strategic environment. In fact, it can be even worse than the throughput under a random allocation mechanism. We then describe a new mechanism that effectively reserves capacity from flexible drivers, even if regulatory or operational constraints limit monetary incentives. This mechanism uses temporal rewards to incentivize a partial separation of driver types, which in turn preserves flexible capacity. As we analyze these mechanisms, we reveal a rather surprising Braess-type paradox. In contrast to the optimal strategy from the non-strategic setting, we show that this new mechanism always performs at least as well as no prioritization. Under practical conditions, it is significantly better. This new mechanism thus offers robust performance across a range of model primitives and assumptions about drivers’ strategies.