Ride-split revenue optimization on ride-sourcing service level and traffic operation

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INTRODUCTION

- Ride-splitting services such as UberPool offer a discount if a user accepts to travel with another rider; discount is independent of actual detour
- Pooling can reduce waiting time and prevent unserved requests, but only if rider accepts to share given the trip costs and duration
- This project models rider acceptance under different pricing policies by creating a discrete-event simulation in a congestible network, and investigates the prospect of ride-splitting as a measure for demand imbalance reduction

SIMULATOR FRAMEWORK

- 3-hour simulated non-uniform taxi demand with 40'000 trips/h in the 1st and 3rd hours, and 80'000 trips/h during the 2nd hour [1]
- Next-event time advance mechanism implemented in Python to carry out matching, pick-up, drop-off, and vehicle movements
- Greedy per-request matching, no knowledge on future demand
- Modal split: ride-sourcing (15%) and private vehicles (85% and abandoned-riding requests)
- Congestion dynamics: reduction in average velocity as a function of vehicle accumulation in the system, calibrated with MFD [1]

Pricing strategies

Six simulation-level incentives are tested to compare their impact on service level, minimum average velocity ($V_{\text{min}}$), and average revenue.

<table>
<thead>
<tr>
<th>Pricing</th>
<th>Description</th>
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<tbody>
<tr>
<td>U</td>
<td>solo $2.20 + x \cdot $1.00/km, shared $2.00 + x \cdot$0.80/km</td>
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<tr>
<td>PR</td>
<td>max $P_{\text{share}}^n \cdot R_{\text{share}}^n \forall n \in {1, j }$</td>
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<td>U+PR</td>
<td>U during the 1st hour, PR for the remaining 2 hours</td>
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<tr>
<td>PPR</td>
<td>max $P_{\text{share}}^j \cdot P_{\text{share}} \cdot (R_{\text{share}}^i + R_{\text{share}}^j)$</td>
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<tr>
<td>U+PPR</td>
<td>U during the 1st hour, PR for the remaining 2 hours</td>
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<tr>
<td>Urel+</td>
<td>U, except PPR for rebalancing in the last 2 hours</td>
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RESULTS

Comparison for fleet sizes of 2500 (small circles) and 4000 (large circles)

CONCLUSION

- Rider preference models are necessary for anticipating the magnitude of operational improvements from ride-splitting, but careful calibration is needed
- User-based incentives can effectively address temporal and spatial demand imbalance, and avoid congestion impacts from large fleet sizes
- Future direction: request-level sharing incentive optimization to target trips that lead to the largest service level improvement; multimodal interaction with transit users

REFERENCES