Management of Empty aTaxis

by

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Key References

• S. Zhu’16 “Making Transportation Great Again” 2016 Senior Thesis
• S. Zhu’16 & A. Kornhauser*71 Interplay Between Fleet-size, LoS and EmptyRepositioning
Basic Problem:

- Demand for aTaxis is NOT Symmetric (even in the long run)
- Thus empty aTaxis end up where no one else wants to get in.
- Thus they need to be repositioned
- If you have a big enough fleet, you may be able to wait a long time, but eventually, you’ll need to reposition them.
FIGURE 2: Number of vehicles on the road as a function of time. The minimum number of vehicles needed to operate the system is the maximum of each vehicle type.
Early Morning Repositioning Costs

\[ \min \sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} D_{ij} T_{ij} \]

subject to \( T \geq 0 \)

\[ T_{i,i} = 0 \]

\[ \sum_{i \in \mathcal{I}} T_{ij} = A_j, \quad \forall j \in \mathcal{J} \]

\[ \sum_{j \in \mathcal{J}} T_{ij} = P_i, \quad \forall i \in \mathcal{I} \]  \( (1) \)

where:

- \( D_{ij} \) is the distance between aTaxi stand \( i \) and aTaxi stand \( j \), calculated as \( 1.2 \times D_{\text{cartesian}} \).
- \( T_{ij} \) is trip matrix, or the number of vehicles moved from aTaxi stand \( i \) to aTaxi stand \( j \).
- \( \mathcal{I} \) and \( \mathcal{J} \) are the set of active aTaxi stand.
- \( P_i \) is the number of excess vehicles available at the aTaxi stand \( i \).
- \( A_j \) is the number of vehicles needed at pixel \( j \).
FIGURE 3: aTaxi stands that can be reached from the departure stand within 5 minutes at 30 mph travel
Near-by Repositioning

Figure 5.2: Voxelization of pixels in local repositioning
Repositioning v Fleet Size: NJ

**FIGURE 4:** Comparison of empty vehicle repositioning cost, as a percentage of loaded vehicle miles traveled, for fleets of varying sizes.
Empty Miles: NJ

FIGURE 5: Histograms of empty distances traveled by vehicle type for the 10% fleet size case in local repositioning.
Empty Miles: 10% Fleet Size case

**FIGURE 6**: Histograms of empty distances traveled by vehicle type for the 10% fleet size case in Early Morning Repositioning.
Summary

**TABLE 3**: Percentage of vehicle trips served within advertised level of service in each repositioning strategy

<table>
<thead>
<tr>
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<th>Fleet Size</th>
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<tbody>
<tr>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Simple Strategy</td>
<td>82.7</td>
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<tr>
<td>Extended Search</td>
<td>86.7</td>
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</tbody>
</table>

**TABLE 4**: Percentage of passengers served as wait time increases beyond advertised level of service for various fleet sizes

<table>
<thead>
<tr>
<th></th>
<th>Fleet Size</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
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<tr>
<td>Within advertised</td>
<td>95.4</td>
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<tr>
<td>Within advertised + 1 minute</td>
<td>95.7</td>
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<tr>
<td>Within advertised + 5 minutes</td>
<td>96.8</td>
</tr>
<tr>
<td>Within advertised + 10 minutes</td>
<td>97.8</td>
</tr>
</tbody>
</table>
Discussion!

Thank You

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www.SmartDrivingCar.com