AUCTION-BASED DISTRIBUTED RIDE-HAILING REBALANCING: THE CASE STUDY OF LYON, FRANCE

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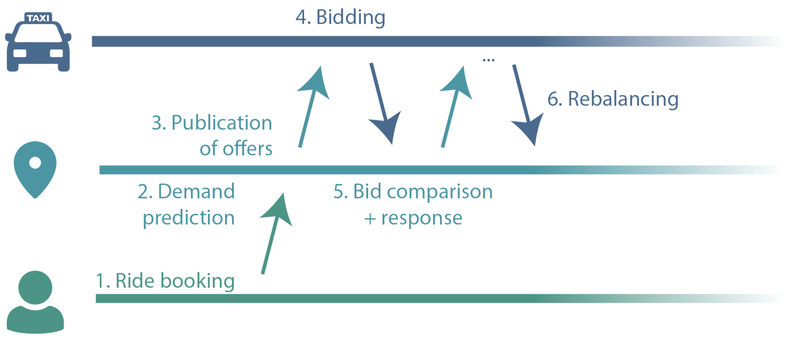
INTRODUCTION

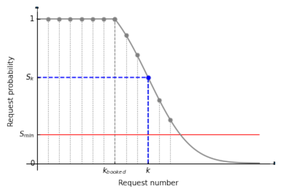
- We propose a multi-agent model populated with **travelers**, **vehicles** and **regional controllers** to address the issue of ride-hailing fleet rebalancing.
- The regional controllers gather **pre-booked requests** and **predict the future local demand**.
- Controllers and vehicles interact in a **two-sided matching market** which assigns rebalancing directions to vacant vehicles.

NEGOTIATION SCHEME

Distributed Gale-Shapley algorithm



Definition of rebalancing offers



- $p_{i,k}$ the probability that at least k ride requests occur in i;

$$p^k = S_X(k) = P(X \geq k) \qquad (1)$$

- $\hat{g}_i$ the expected income from serving a passenger in region i.

Agents utility functions

- Vehicles aim at **maximizing their net income**, *i.e.*, difference between ride profits and rebalancing costs:

$$u_v(r_i, k) = p_k \cdot \hat{g}_i - c_v^{km} \cdot d_{SP}(p_v, p_{r_i}) \qquad (2)$$

- Controllers aim at ensuring **vehicles arrive on time** for picking-up passengers and therefore favor the nearest vehicles in travel time.

DIT4TraM

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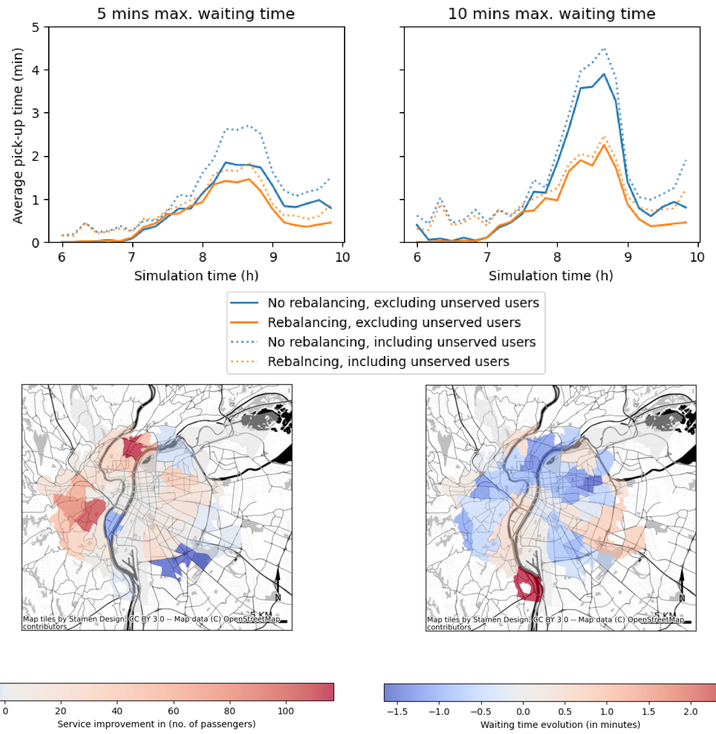
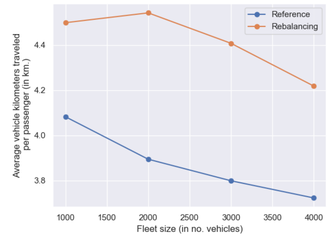
RESULTS

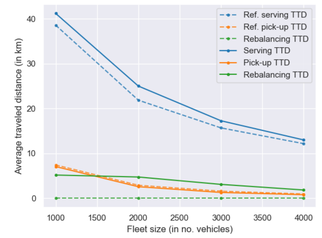
Service quality

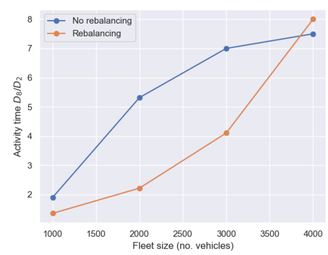
Waiting tolerance		5 minutes				10 minutes			
		Ref.	Control	Diff.	%	Ref.	Control	Diff.	%
Served passengers	Global	13,647	14,764	1,117	8.18	14,837	15,121	284	1.91
	Peak hour	4,996	5,916	920	18.41	5,940	6,225	285	4.80
Waiting time (in min.)	Global	1.50	1.01	-0.50	-33.07	2.11	1.27	-0.84	-39.90
	Peak hour	2.35	1.56	-0.79	-33.72	3.63	1.93	-1.70	-46.74

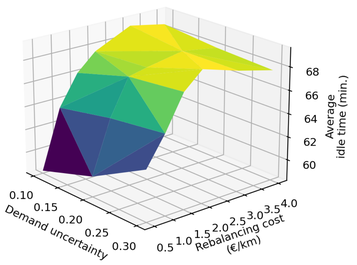


Service performances





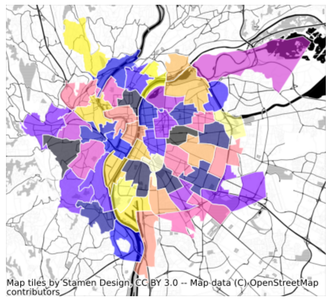




TAKE AWAYS

- Fleet rebalancing reduces both passengers waiting time and service abandonment rates.
- The least accessible regions benefit the most from the strategy.
- The rebalancing strategy foster equity between drivers.
- These benefits come at the expense of travel distances.
- High demand uncertainty and rebalancing costs extend vehicle idle phases.

CASE STUDY



- City of Lyon, France
- Partitioned into 50 service areas
- 4 hours of morning peak
- Simulations conducted on MnMS (trip-based simulator) platform.

PERSPECTIVES

Short term perspectives

- Development of local incentives to reduce demand uncertainties and ensure profitability.

Long term perspectives

- Foster inter-regional cooperation with limited information sharing.
- Evaluate performances with multiple operating services.