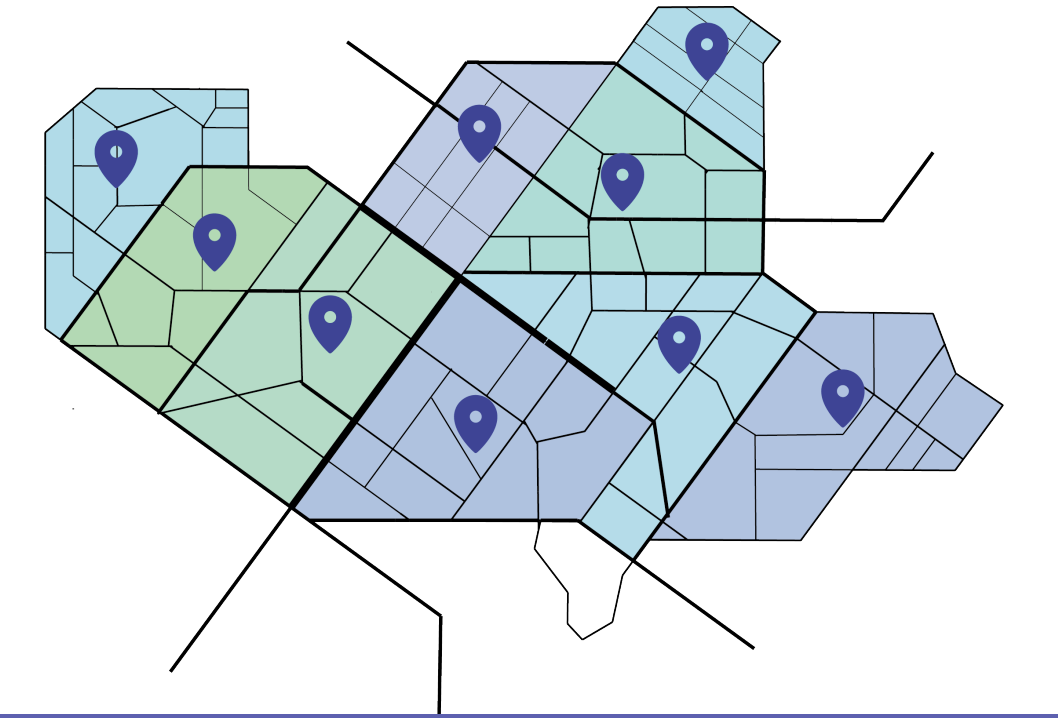
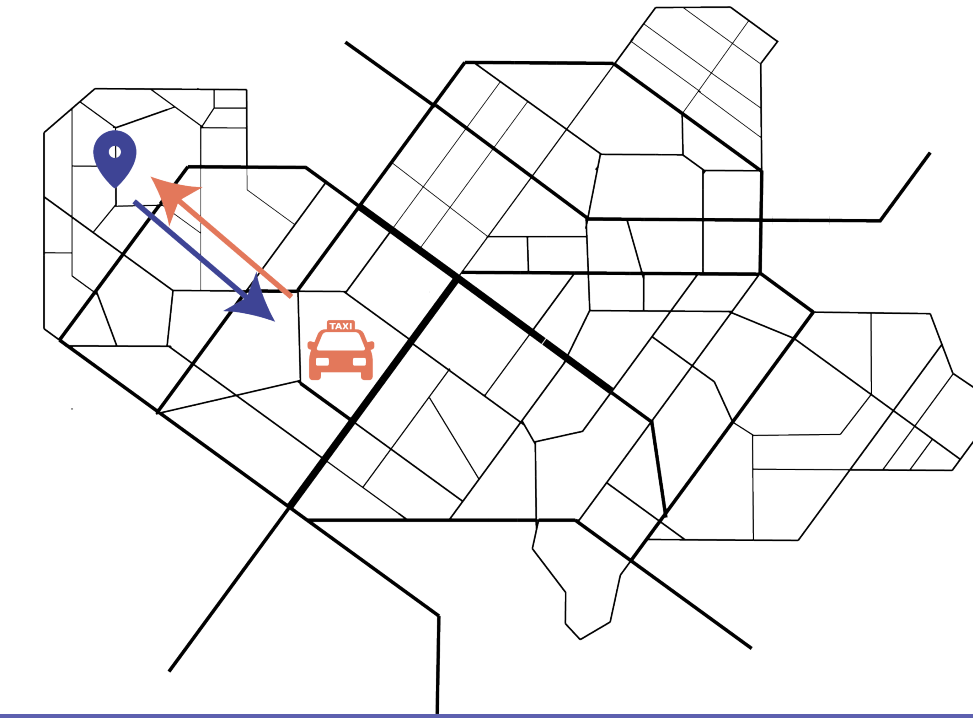
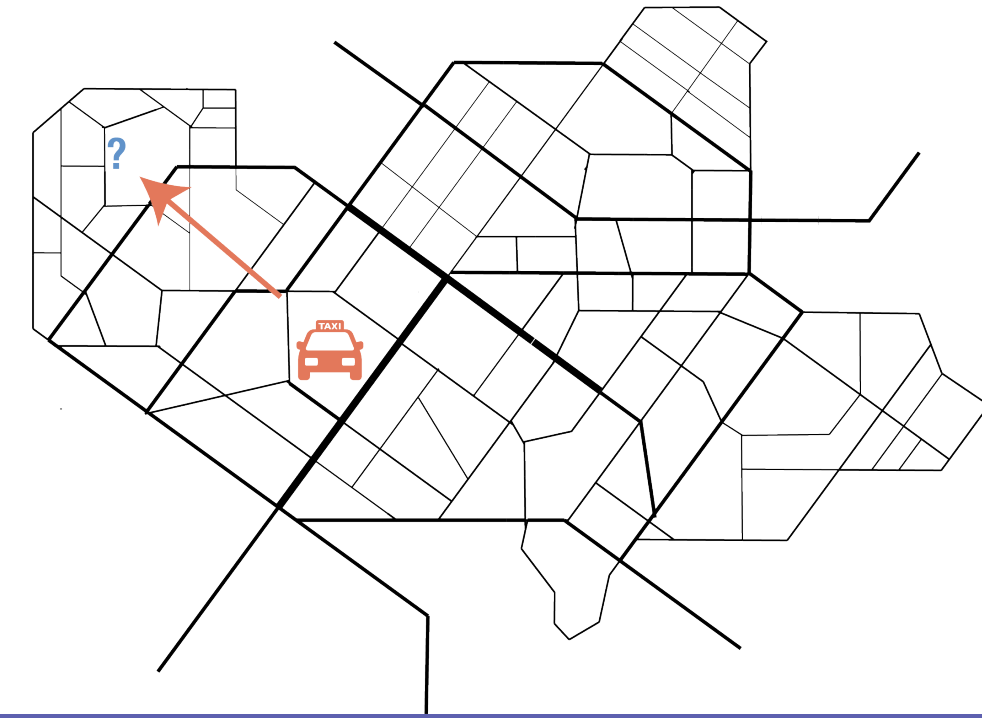
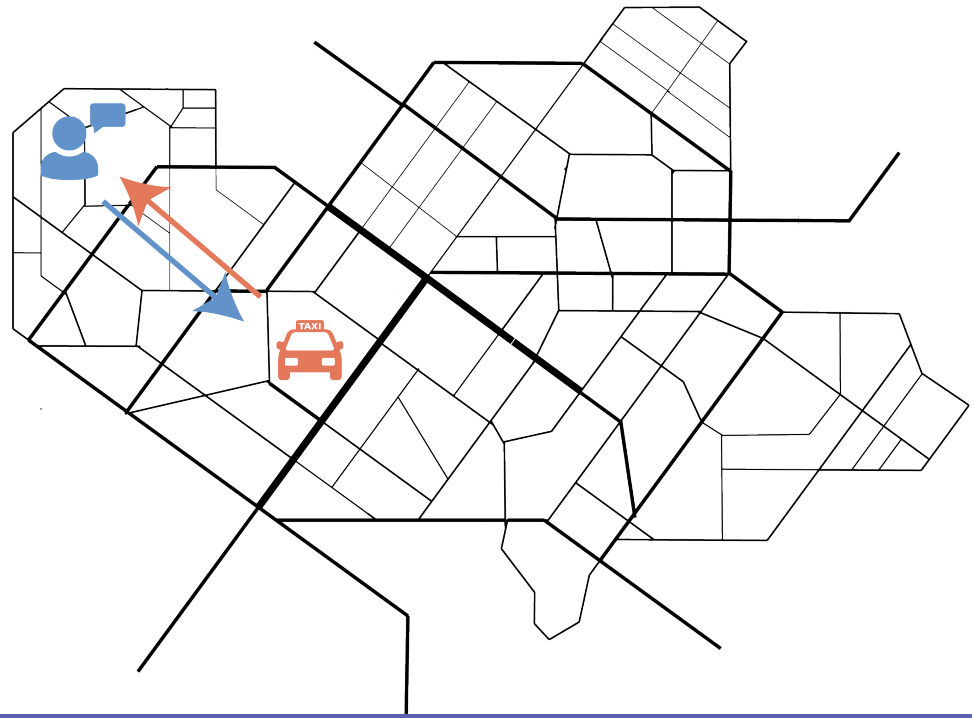


A DECENTRALISED AUCTION-BASED FRAMEWORK FOR REBALANCING RIDE-HAILING FLEETS WITH UNCERTAIN REQUEST PROBABILITIES

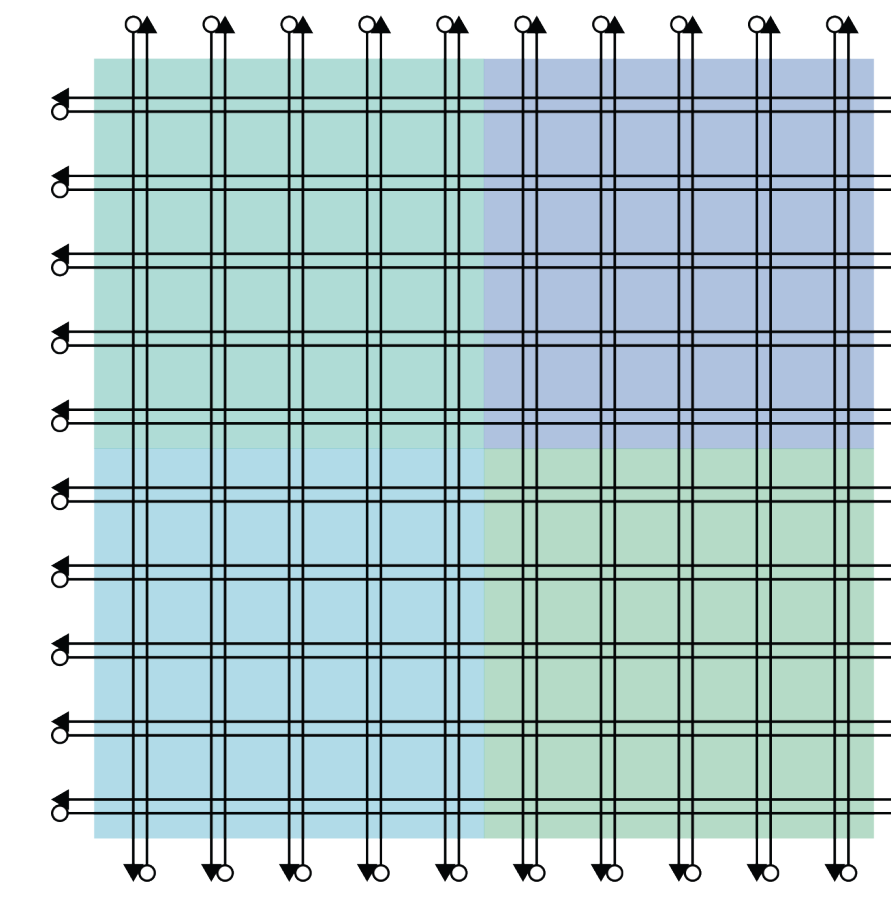
Manon Sepecher and Ludovic Leclercq
Univ. Gustave Eiffel, Univ. Lyon, ENTPE, LICIT-ECO7 UMR T9401, F-69675, Lyon (France)



INTRODUCTION

- Multi-agent model model populated with **travellers, vehicles and regional controllers**.
- Regional controllers gather **pre-booked requests** and **predict the overall local future demand**.
- Regional controllers and vehicles interact in a **two-sided matching market** which assigns rebalancing decisions to vacant vehicles.

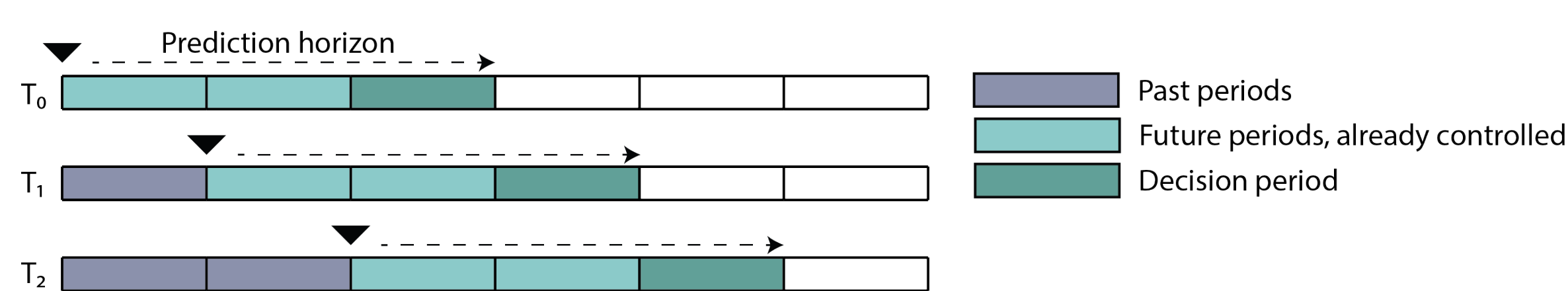
CASE STUDY



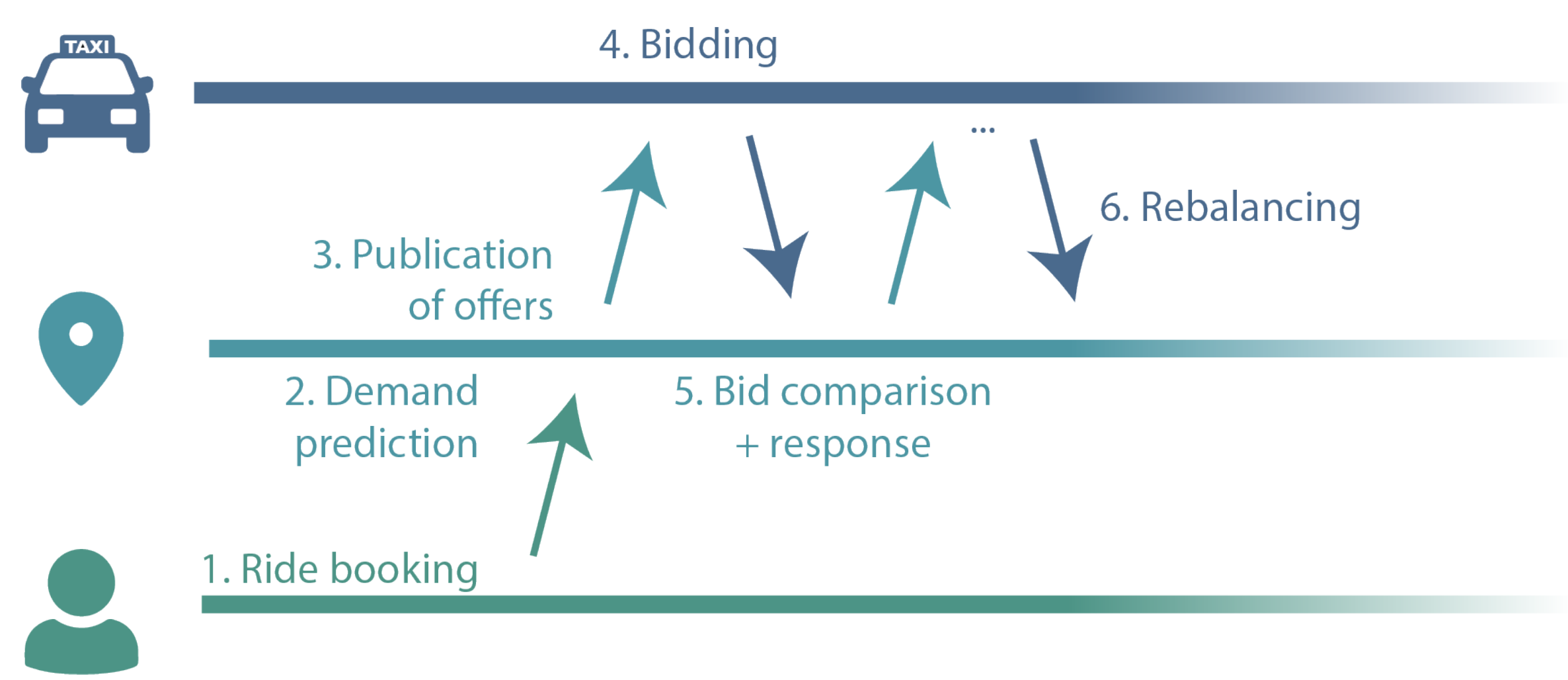
- Manhattan network.
- 4 service areas controlled by a regional controller.
- A polarised demand peak from 3 regions towards the 4th one.
- Simulations conducted on MnMS (trip-based simulator) platform.

NEGOTIATION SCHEME

Temporal scheme



Distributed Gale-Shapley algorithm

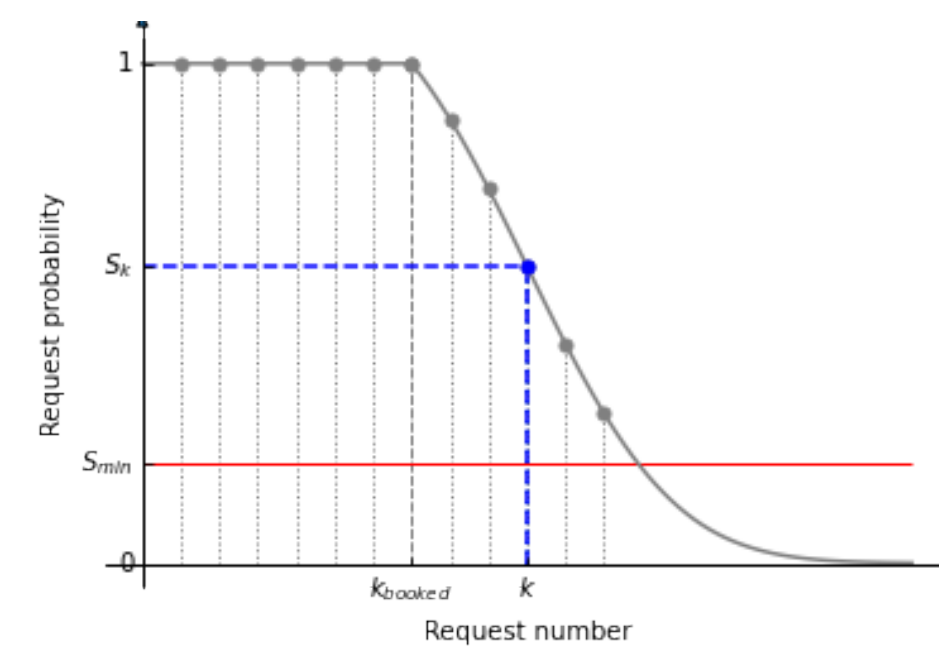


Assumption on demand prediction

- The total demand of one region is modelled as:

$$X_i^T \sim N(\mu_i^T, (\sigma_i^T)^2) \quad (1)$$

Definition of rebalancing offers



- $p_{i,k}$ the probability that at least k ride requests occur in i ;
- $p_{i,k} = S_{X_i^T}(k) = P(X_i^T \geq k) \quad (2)$
- \bar{g}_i the expected income from serving a passenger in region i .

Agents utility functions

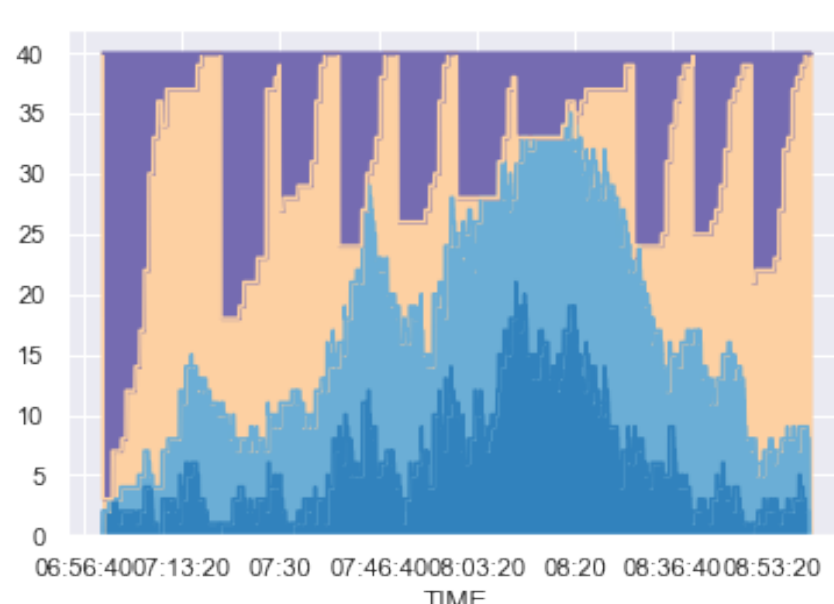
- Vehicles aim at **maximising their net income**:

$$U_v(i, k) = p_{i,k} \cdot g_i - c_v^{km} \cdot d_{SP}(p, i) \quad (3)$$

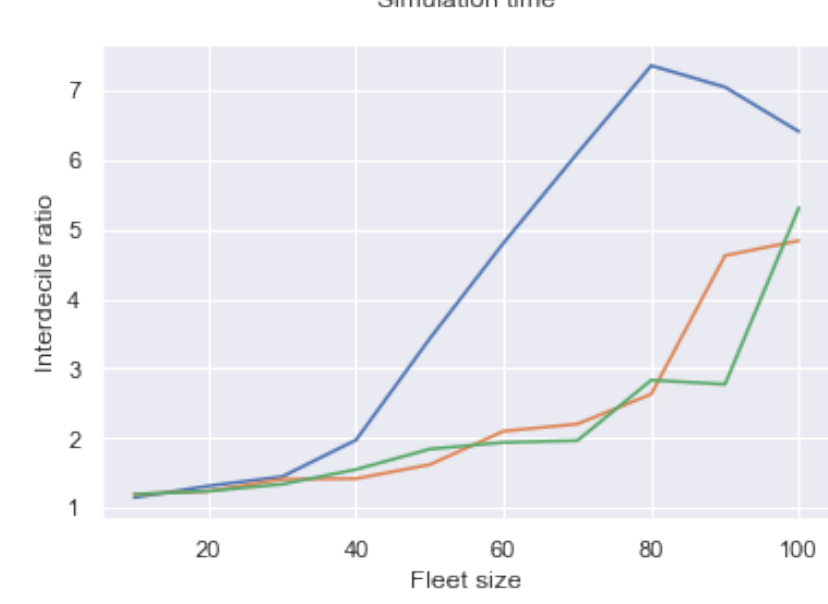
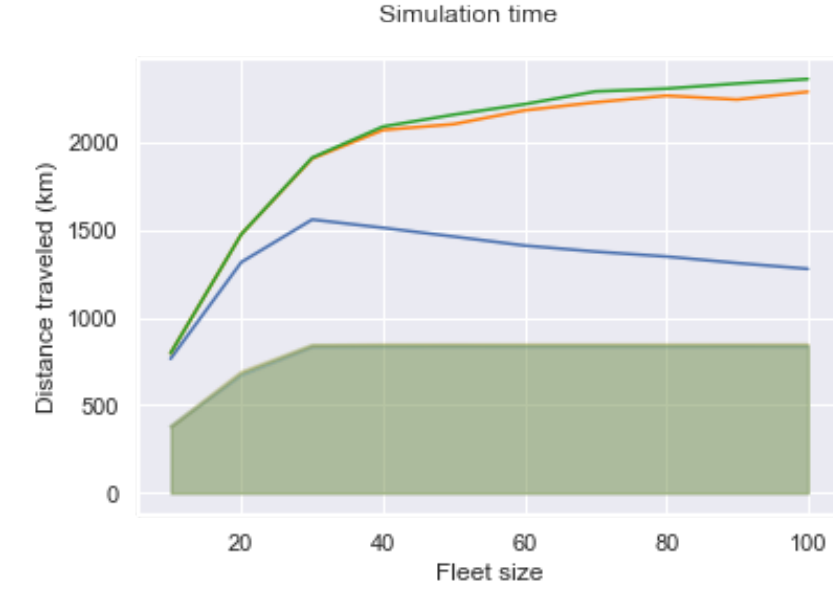
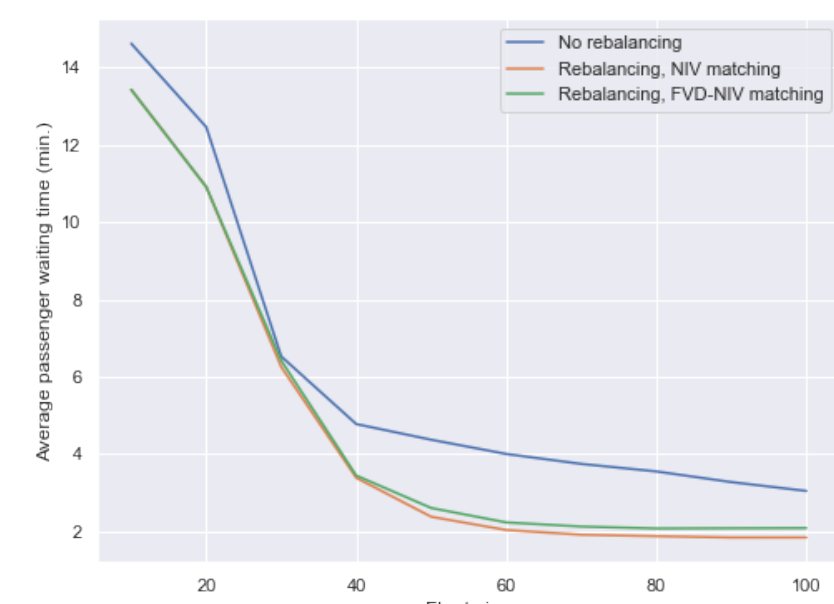
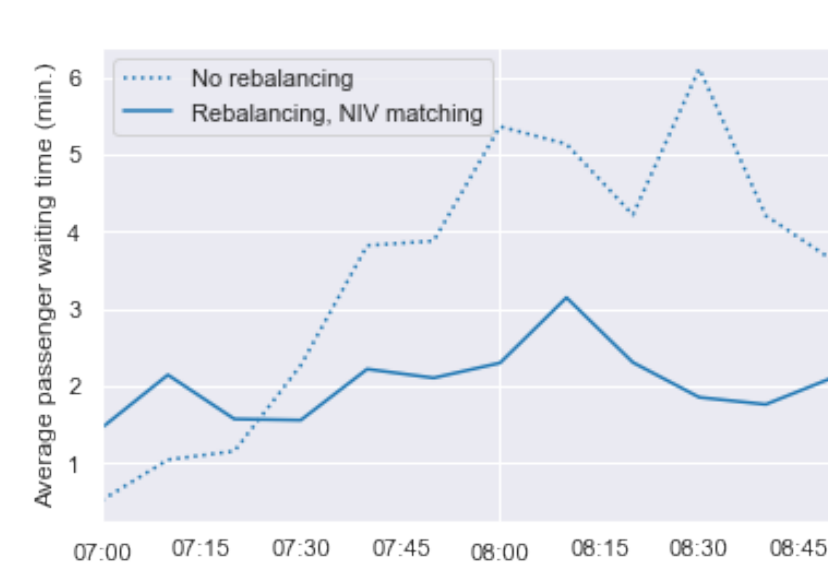
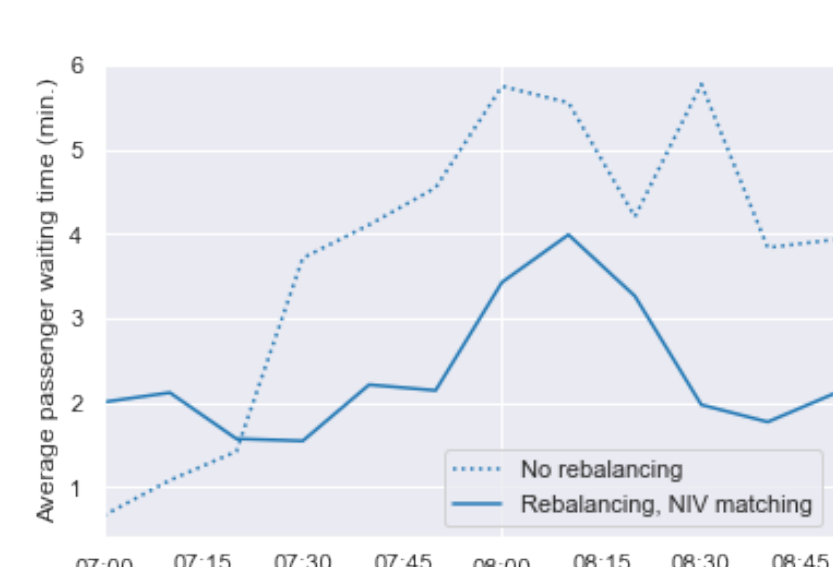
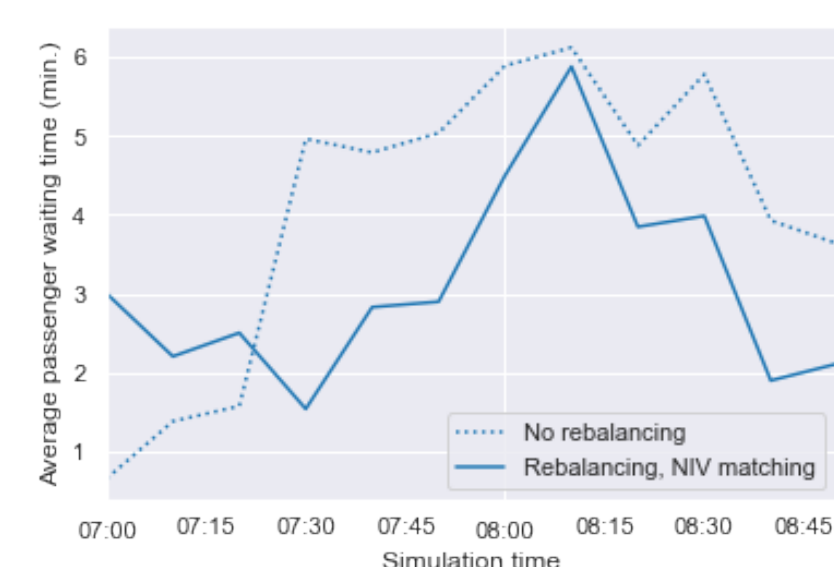
- Controllers aim at **maximising the probability that the vehicles is in the area** upon a request reception:

$$U_{i,k}(v) = P(Y_v < X_k < Y_v + \tau_v) \quad (4)$$

RESULTS



- Passengers waiting time decreases
- Equity between drivers increases
- Overall travel distances increases as well



DISCUSSION AND FUTURE WORK

Current work

- Exploration of specific features: travelled distance, sensitivity to uncertainty and distance.
- Implementation on Lyon, France.

Short term perspectives

- Adaptation to ride-sharing operations.
- 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.