Multiagent Coordination In On-demand Transport with Connected Autonomous Vehicles

A decentralized resource allocation approach

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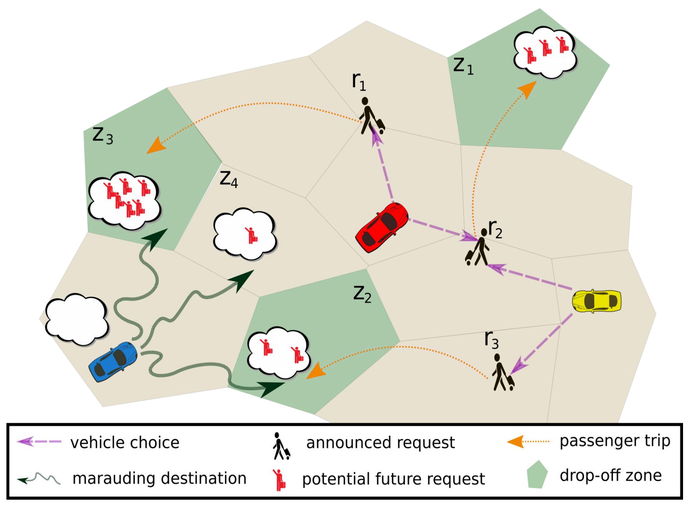


Application domain : On-demand Transport (ODT)

AV-OLRA

An extension to a more generic model (OLRA) adapted to ODT with AVs and their communication constraints

(R,V,G,T)

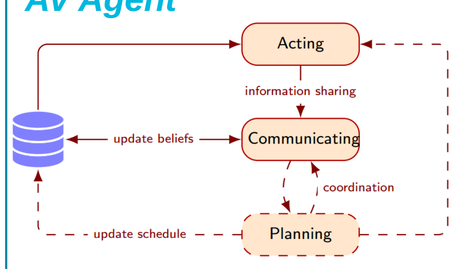
- ***R*** – a dynamic set of requests (ressources)
- ***V*** – a set of connected autonomous vehicles (consumers with communication constraints)
- ***G*** – a graph defining the road network
- ***T*** – the problem's time horizon (discretization of time dimension)

Deploying autonomous vehicle fleets, with limited communication ranges, in order to provide ODT service requires a careful choice and evaluation of solution methods for resource allocation problems.

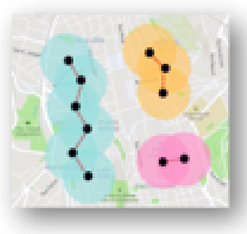
Our Multiagent Approach

- **Generic Modeling** *(AV-OLRA)* – Autonomous Vehicles Online Localized Resource Allocation: *A generic model to ODT's dynamic resource allocation problem in connected autonomous vehicle fleets, taking into account the limited connectivity and communication constraints*
- **Behavior Abstraction** *(AV Agent)* – Each Autonomous vehicle is an agent whose behavior consists of 3 sub-behaviors: (Acting, Communicating and Planning)
- **Solution Abstraction** *(CM)* – A coordination mechanism defines the characteristics of a solution methods and requirements to implement the corresponding planning sub-behavior
- **Evaluation Testbed** *(AV-SIM)* – A multiagent simulator based on "Plateforme Territoire" with a set of evaluation criteria (QoB, QoS, Communication load, Connectivity)
- **A new solution method** *(ORNInA)* – A Decentralized, Auction-based, coordination approach with run-time optimization

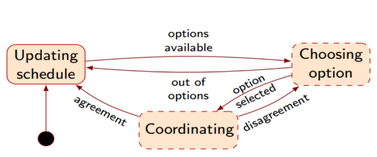
AV Agent



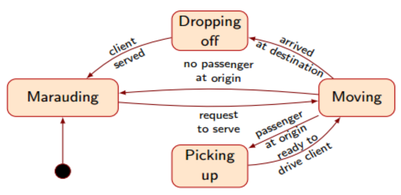
Generic Autonomous Vehicle Behavior



Communication model connected sets (CSs) are formed through vehicles limited communications ranges

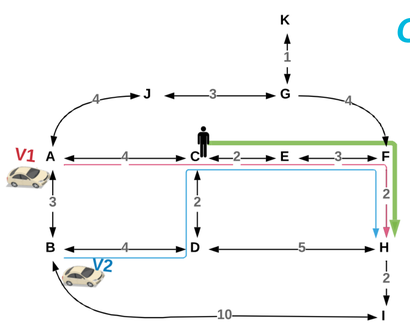


Planning sub-behavior
The coordination mechanism defines the solution method

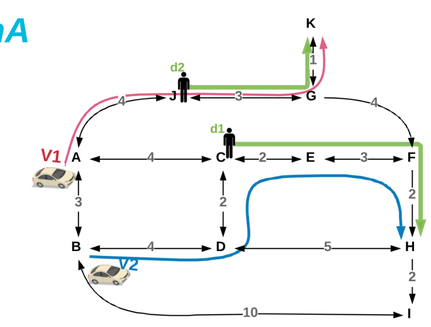


Acting sub-behavior

ORNInA

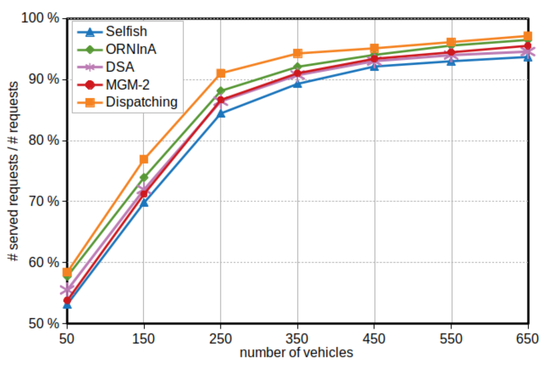


Auction Based Insertion heuristic

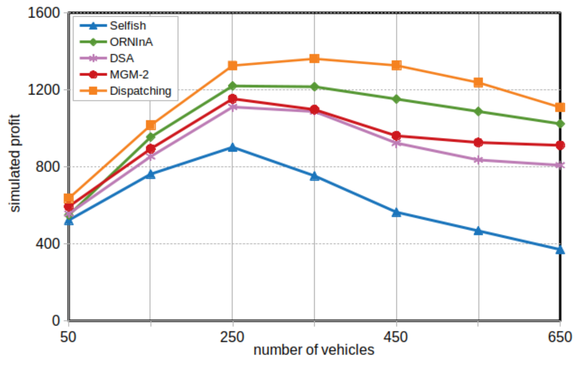


Run-time optimization (request exchange)

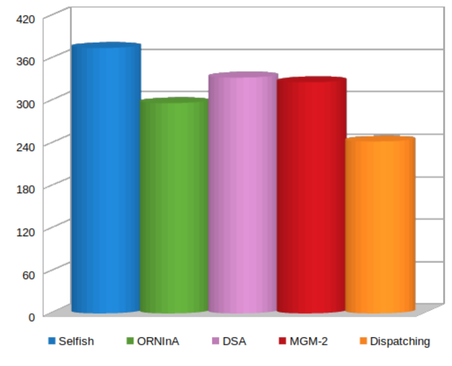
Experimental evaluation with AV-SIM on real-world data (NYC-TLC trip records)



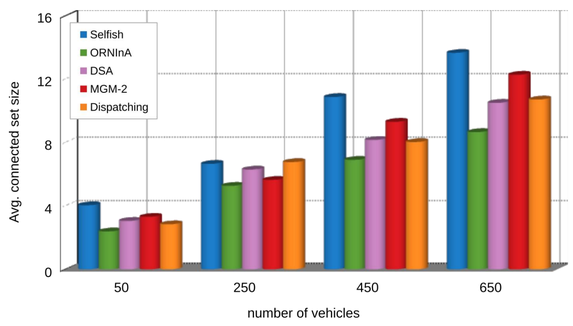
QoS Evolution



QoB Evolution



NB vehicles required for 90% QoS



Connectivity vs. NB vehicles

- The problem is split into sub-problems (per CS), the global solution is an aggregation of the sub-solutions
- Consequences of increasing the number of vehicles (enlarging the fleet size) :
  - More requests are served (better QoS) with more operational cost (a decrease in QoB after some threshold)
    => **a trade-off** :QoS vs. QoB
  - More connectivity between vehicles (larger connected set sizes)
    => more coordination messages and communicational cost
- The centralized (**Dispatching)** is optimal for (fleet size / QoS), the greedy method **(Selfish)** is the worst, while decentralized coordination methods **(MGM-2, DSA, ORNInA)** are good alternatives in the middle (ORNInA performs slightly better with lower communicational cost)

OBJECTIFS DE DÉVELOPPEMENT DURABLE
11 VILLES ET COMMUNAUTÉS DURABLES

Plateforme Territoire

References

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