A Generic Multi-Agent Model for Resource Allocation Strategies in Online On-Demand Transport with Autonomous Vehicles

Alaa Daoud, Flavien Balbo, Paolo Gianessi, Gauthier Picard

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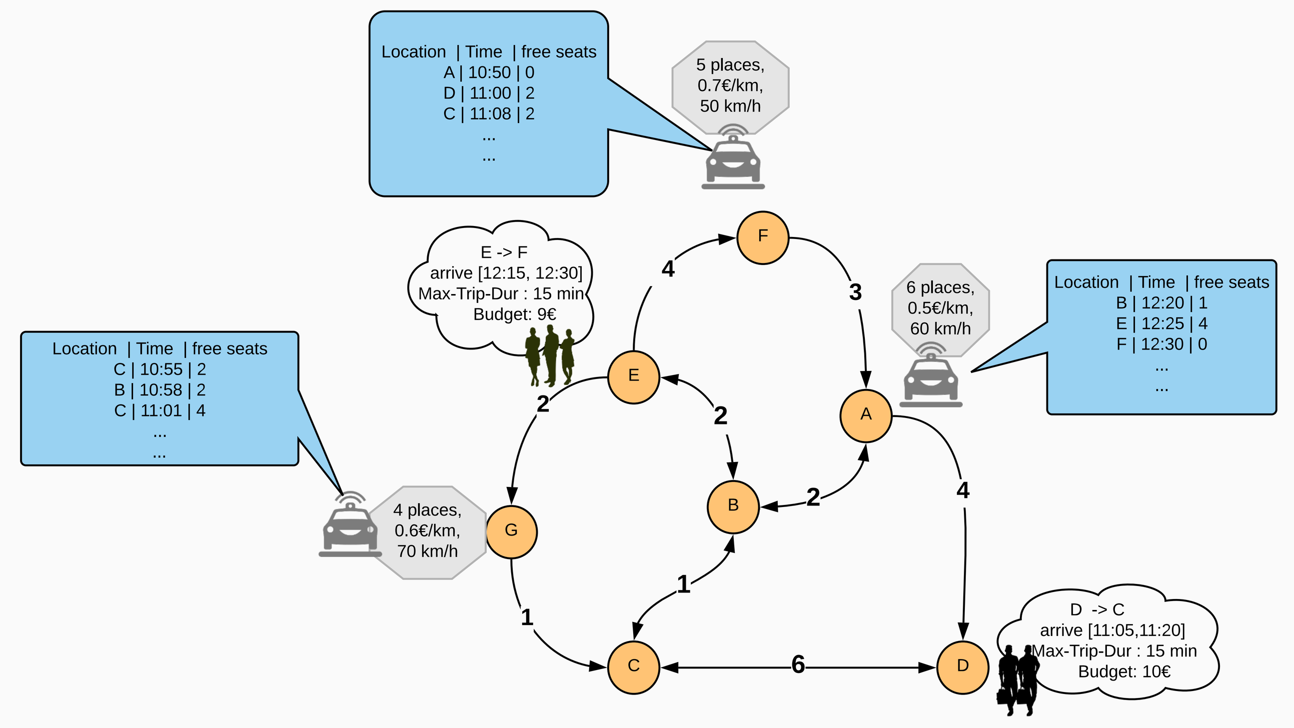
Application domain: On-demand transport (ODT)



Simple instance of ODT problem

AV-OLRA model

Autonomous Vehicles Online Localized Resource Allocation

A generic model to ODT's dynamic resource allocation problem in autonomous vehicle fleets with communication constraints

$$\langle \mathcal{R}, \mathcal{V}, \mathcal{G}, \mathcal{T} \rangle$$

- $\mathcal{R}$: a dynamic set of requests
- $\mathcal{V}$: a fleet of m vehicles
- $\mathcal{G}$: a graph defining the road network
- $\mathcal{T}$: the problem's time horizon

Solution methods

Depends on the adopted coordination mechanism (CM)

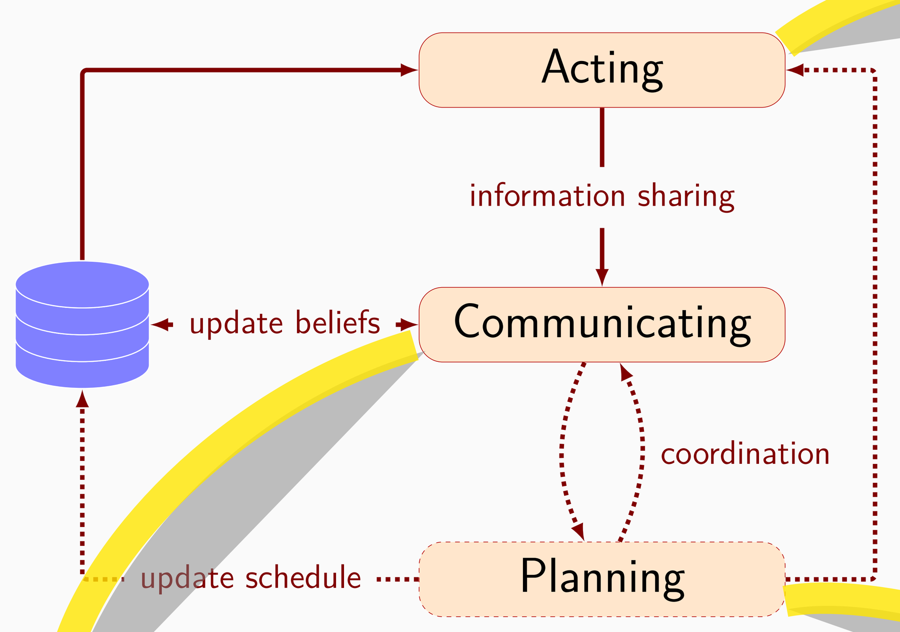
$$CM := \langle DA, AC, AM \rangle$$

- DA: level of decision autonomy centralized (C) / decentralized (D)
- AC: agents' cooperativeness level "sharing" (S) / "no-sharing" (N)
- AM: the allocation mechanism

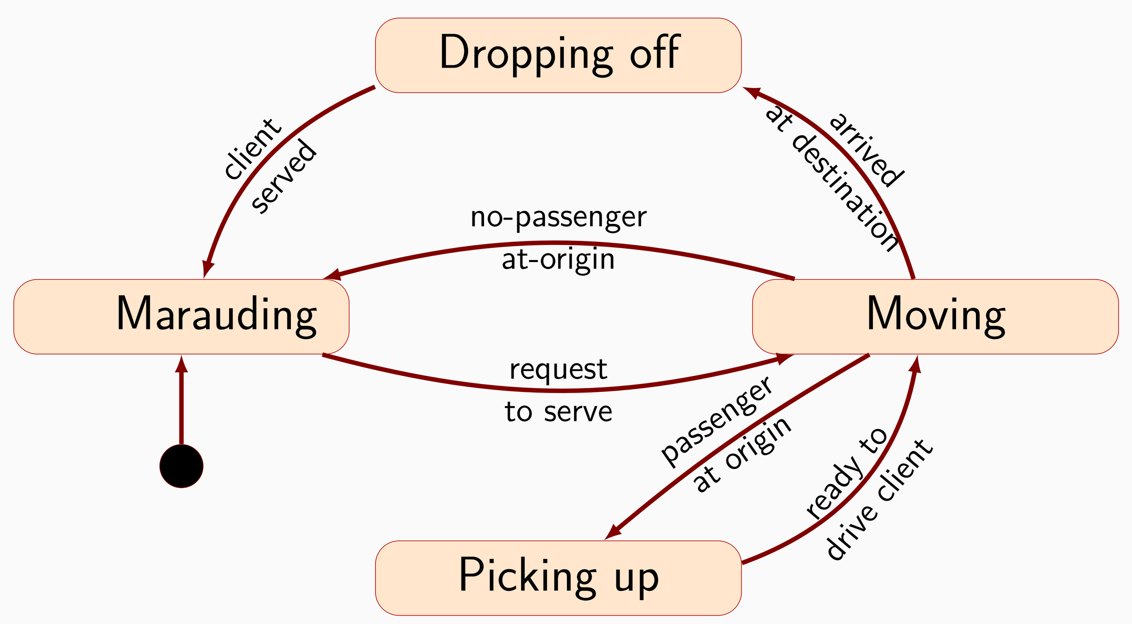
Implementation examples

- *Selfish*: $\langle D, N,$Greedy$\rangle$ [3]
- *Dispatching*: $\langle C, S,$MILP$\rangle$ [2]
- *Auctions*: $\langle D, S,$Auction$\rangle$ [1]
- *Cooperative*: $\langle D, S,$DCOP$\rangle$
  MGM-2 solver [4]
  DSA solver [5] (variant A, $p = 0.5$)

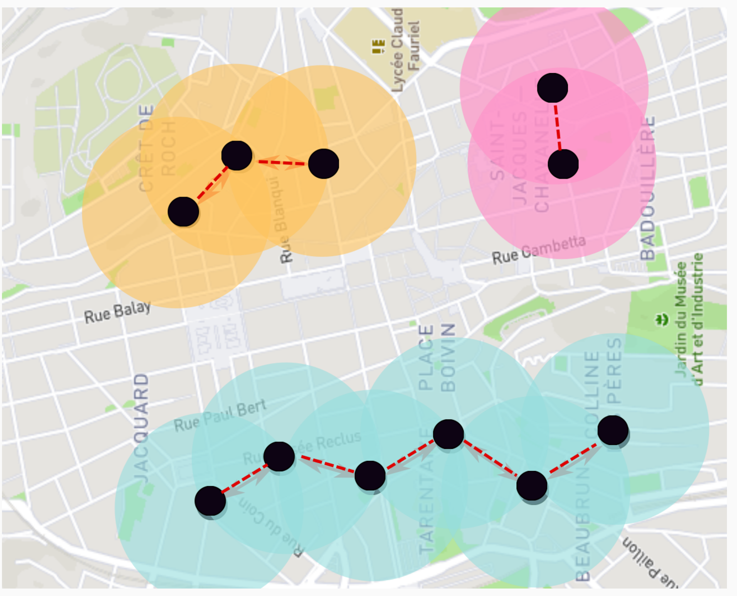
Generic AV Behavior



Acting Sub-behavior

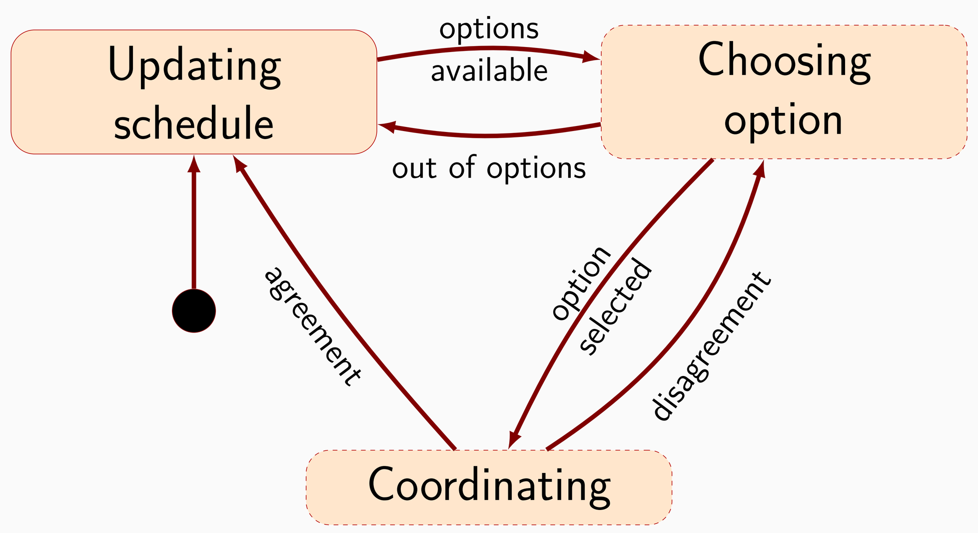


Communication Model

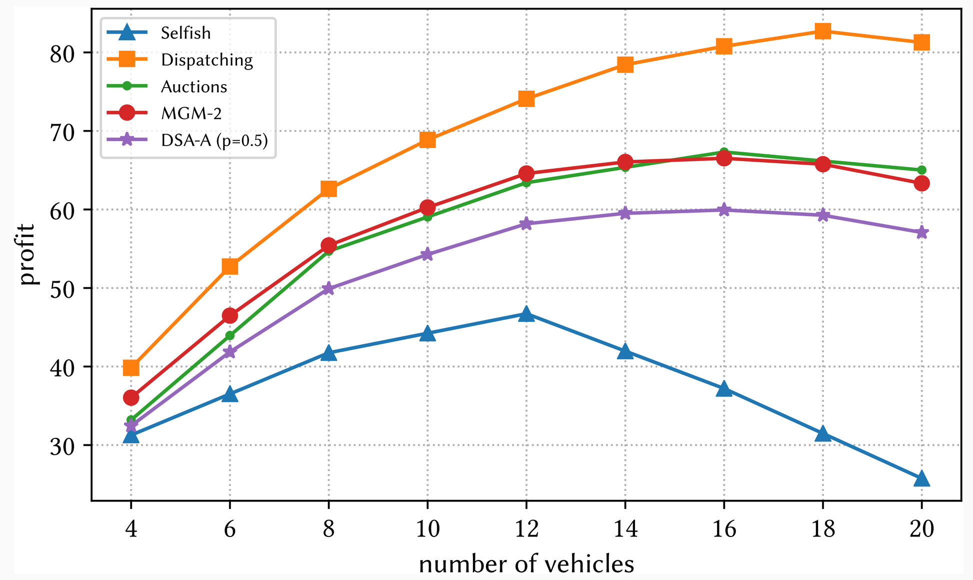


Vehicles form connected sets through their limited-range communication

Planning Sub-behavior



Evaluation



QoB evolution with the increasing flee size

Coordination	message size max	avg	msg per agent	comm. load (MB)	reschedule rate
Selfish	140	88	6	2.21	2.0
Dispatching	3500	168	21	11.2	3.0
Auctions	140	112	53	37.7	1.5
MGM-2	210	25	5040	297.6	12.0
DSA	236	20	5015	75.1	13.0

Metrics for scenarios with 10 vehicles

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