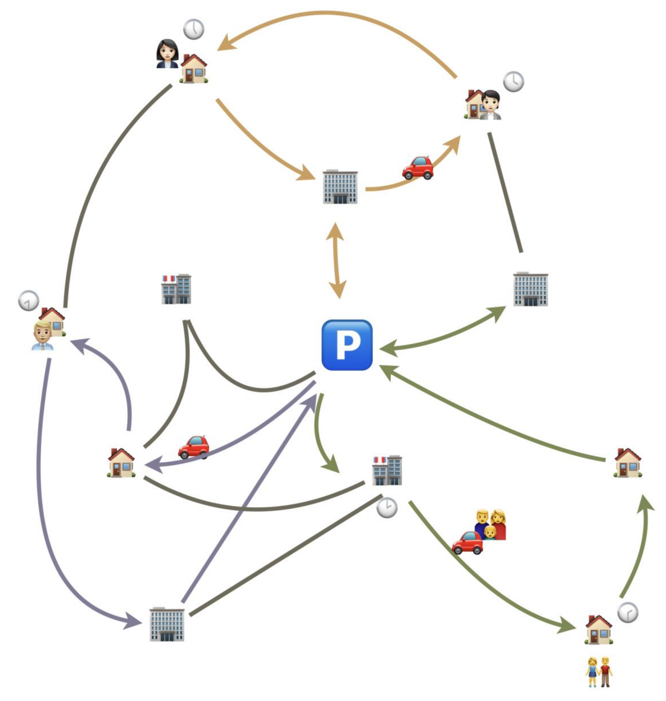
Models and Algorithms for the Management of New Urban and Rural Mobility Services

The large-scale shared autonomous vehicle dial-a-ride problem



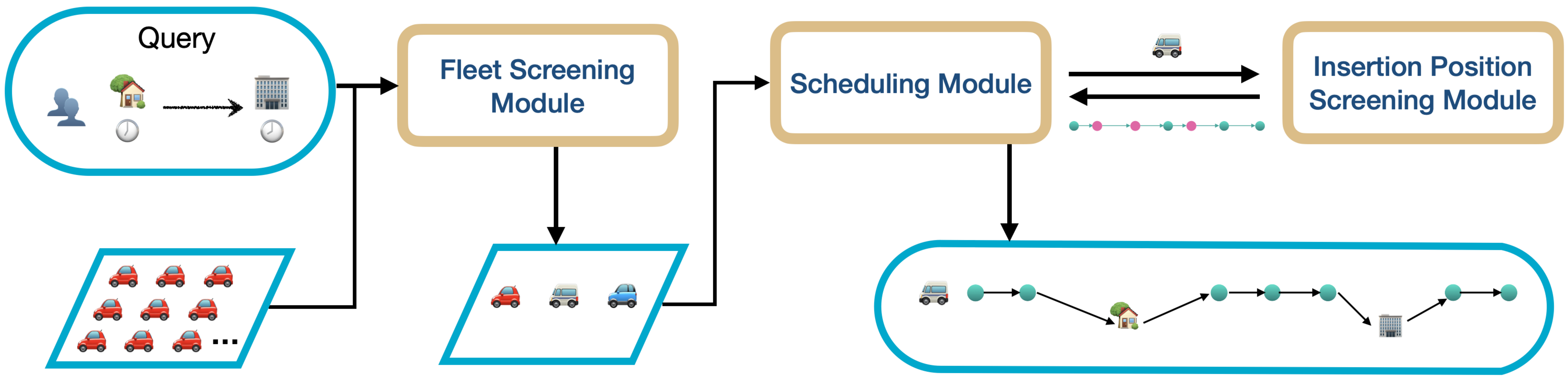
Objective

We aim to solve a **large-scale SAV** (Shared Autonomous Vehicle) **DARP** (Dial-A-Ride Problem), where the system has to process a large number of passenger requests (around 100,000 for a time horizon of 10h per day). One of the main objectives is to speed up the dispatching and scheduling process while maintaining a good decision quality. For this, we introduce different techniques:

▶ The use of a **fleet filter** in order to quickly identify a small subset of SAVs that are worth exploring given a passenger request.

▶ The use of an **insertion position filter** in order to quickly identify a subset of insertion positions within the route of a candidate SAV that are worth examing.

The system framework



The fleet screening module

▶ **The fleet filter:** We introduce an index matrix M, serving as a fleet filter. The road network and time horizon are partitioned into zones and periods. Each cell $M[z,h]$ contains a set of SAVs that could potentially reach the zone z during the period h.

▶ **The fleet screening process:** Given a new passenger query, we explore simultaneously from the origin and the destination sides all the cells with zones and periods related to the query, take all the concerned SAVs, sort them by score and keep the first few to form the candidate set.

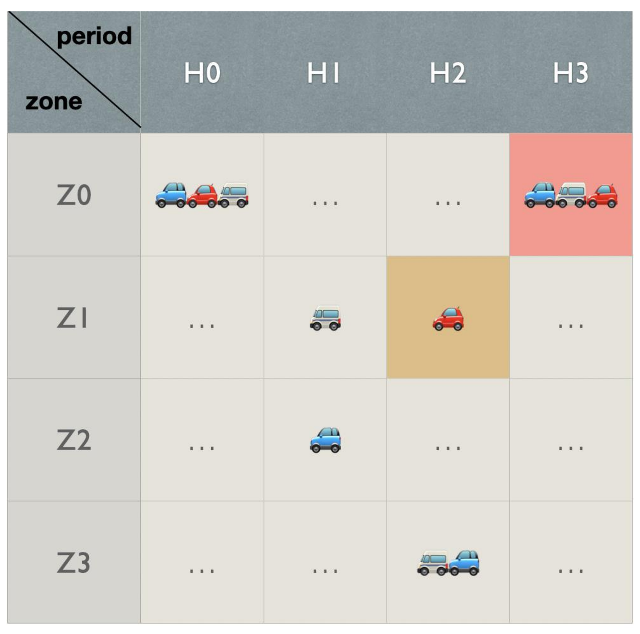


Illustration of the fleet filter M. The new query's origin is related to the zone Z1 and the period H2, while its destination is related to the zone Z0 and the period H3. The corresponding cells M[Z1, H2] and M[Z0, H3] are thus simultaneously taken into account.

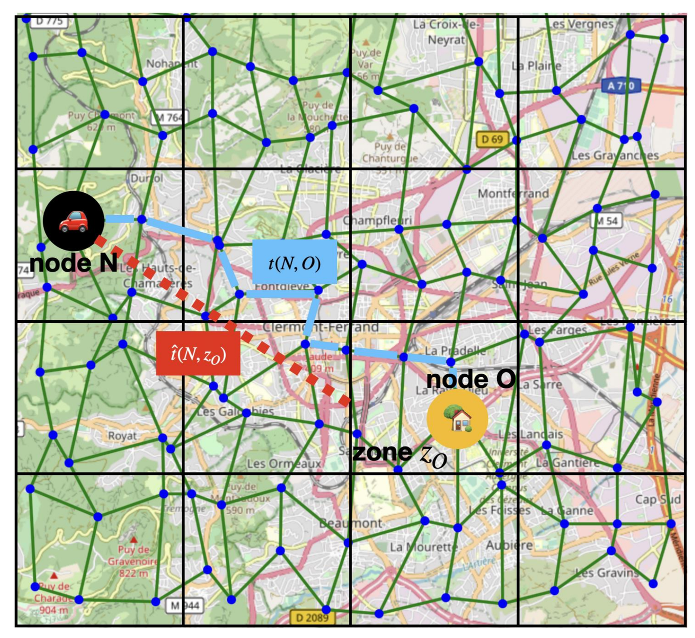
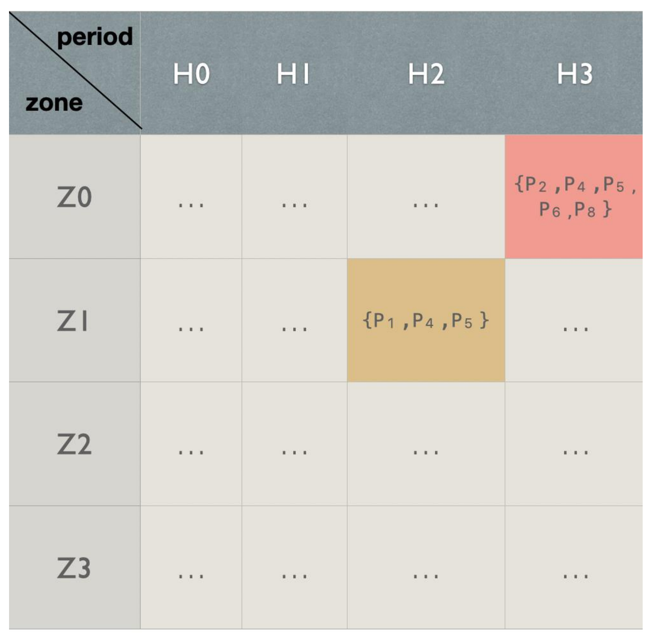


Illustration of the partition of the road network and a basic example. An SAV is scheduled to pass the node N during a certain time window. To know departing from N, whether it can reach the origin O of the target request, we first check if it can approximately pass the zone Zo using the estimated node-zone travel time (represented by the red dotted line).

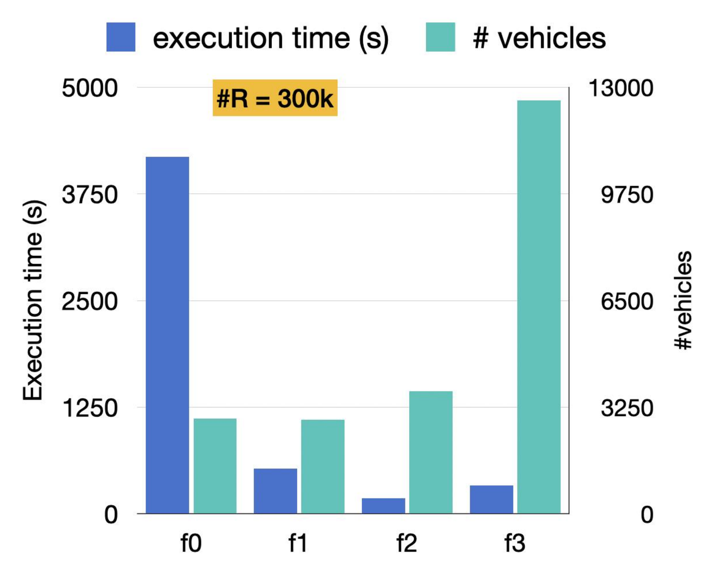
The insertion position screening module

▶ **The insertion position filter:** For each SAV, a structure M^v_{aux} is used to serve as an insertion position filter. Each cell $M^v_{aux}[z,h]$ contains a set of points, departing from which the SAV could pass the zone z during the period h.

▶ **The insertion position screening process:** Given a candidate SAV, the insertion positions for the query's origin and the destination are selected from the related cells of M^v_{aux}. In addition, a position is called a candidate only if it could arrive at the target zone during the time window imposed by the query.



The fleet filter M^v_{aux} for the candidate vehicle v. The new query's origin is related to the zone Z1 and the period H2, while its destination is related to the zone Z0 and the period H3.The corresponding cells M^v_{aux}[Z1, H2] and M^v_{aux}[Z0, H3] are thus respectively taken into account while



Test results on a network with 130 nodes and 474 arcs.
f0: no filter applied; f1: the SAV candidate set contains all the SAVs found by the fleet filter M; f2: the SAV candidate set contains the top 10 selected SAVs; f3: the SAV candidate set contains the top 5 selected SAVs.

Stakeholder

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