SUBPART FIVE

Commercial Traffic

CHAPTER 24

Freight Traffic

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24.1 Basic Information

Entry point to documentation:

`http://matsim.org/extensions` → freight

Invoking the module:

`http://matsim.org/javadoc` → freight → `RunChessboard` class

Selected publications:

Schröder et al. (2012); Zilske et al. (2012)

Various MATSim freight traffic modeling approaches have been implemented in recent years.

For Zürich, available origin-destination matrices for small delivery trucks and heavy trucks have been disaggregated Shah (2010). Data was taken from the KVMZH (Kantonales Verkehrsmodell Zürich) provided by Amt für Verkehr, Volkswirtschaftsdirektion Kanton Zürich (2011) and documented in Gottardi and Bürgler (1999). This special freight sub-population is restricted to route choice.

In South Africa, freight vehicles' plans were derived from GPS records of more than 30 000 commercial vehicles tracked over a 6-month period. Activity chains' extraction from raw GPS data was documented in Joubert and Axhausen (2011); the first joint private car and freight implementation appeared in Joubert et al. (2010). In Nagel et al. (2014), we used MATSim to evaluate the impact of a complex vehicle-type specific toll structure where sub-populations, including freight, have different time values.

The most sophisticated solution, however, was the introduction of carrier agents, described in the following section.

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24.2 Carriers

Until now, real-world scenarios set up with MATSim modeled freight traffic demand share by using plan sets with activities at the depot and pick-up and delivery locations, without variability in any dimension except route choice. We improved this situation by modeling freight vehicles as non-autonomous agents employed by, and serving the interests of, freight operators. Freight vehicle drivers' missing choice dimensions are then realized as logistics decisions made by the freight operators who employ them. In the freight transport sector, decisions are distributed among actors with different roles. Freight transport decisions include: lot-size choice, path-searches in logistical networks, vehicle choice and tour planning. A freight operator's planning problem is quite different from its passenger counterpart.

First, success of freight transport plans is not determined by the utility of time spent at activity locations, but rather by commercial success. Plans must fulfill customers' requirements, i.e., time windows and providing sufficient capacity at reasonable cost.

Second, freight operators often operate several vehicles and their options include rescheduling deliveries from one vehicle to another or even changing the number of vehicles used.

Thus, a new software layer populated by *carrier agents* was introduced into the simulation. Each carrier agent represents a firm with a vehicle fleet, depots and contracts. Contracts determine type and quantity of goods to be carried and contains the respective origin and destination as well as pick-up and delivery time windows.

The carrier agent's plan contains a tour schedule for each fleet vehicle, containing planned pick-up, delivery or arrival times at customer locations and a route through the physical network. In our basic model, all vehicle schedules of a carrier begin and end at one of its depots. When a simulation scenario is initialized, the carrier agents build a schedule for each of their vehicles, including a route through the transport network, with pick-up and delivery activities corresponding to their contracts. At the interface between the freight operator plans and the mobility simulation, the set of routed vehicles from each carrier plan is injected into the traffic demand as individual driver agents, where they move through the traffic system along with passenger vehicles. While executing their plans, the freight driver agents report their shipment-related activities back to the carrier.

When all plans have been executed, agents evaluate the success of their plan. The carrier agents use a custom utility function capturing their economic success. Their cost is calculated as a sum of vehicle-dependent distance and time costs incurred by scheduled vehicles, as well as some individual fixed costs, plus penalties incurred by missed time windows.

Finally, carrier agents create new plans to improve their performance in the next iteration. For instance, a time-dependent vehicle routing heuristic can be plugged in to replan vehicle schedules. Shipments can be switched between vehicles, or an entire vehicle added or removed. During repeated executions of their plans, passengers as well as carriers gain experience from the transport system. The carriers experience congestion and other disturbances in the traffic system when they incur a higher cost through longer vehicle usage, or by penalizing missed pick-up and delivery times.

The planning algorithms themselves are implemented in the project `jsprit`, a library separate from MATSim. In the replanning phase of each iteration, `jsprit` is called and replans the carrier plans.

The model is described in a paper by Schröder et al. (2012). For more details about the implementation, as well as more references, see the technical report by Zilske et al. (2012).