# Lightweight Preprocessing for Agent-Based Simulation of Smart Mobility Initiatives

## A technical focus on the experimental setup

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The scope of this report is to provide a more detailed and clear view of the experimental setup behind the experiment described in sections 5 and 6 of the paper *Lightweight Preprocessing for Agent-Based Simulation of Smart Mobility Initiatives*, (published in LNCS Workshop Proceedings of SEFM 2017) [2]. The content of the present document is thus addressed to those who have already read the above mentioned paper.

## Experimental setup of the Smart Mobility Initiatives

For the sake of a fair comparison, the 9 Smart Mobility Initiatives (SMIs) proposed in the experiment all share the same scenario, i.e. the urban road network of the chosen geographical area together with its population. Since the purpose of the experiment is to test the positive correlation between the output variables of Tangramob and ToolTRain, the number and location of tangrhubs is fixed for all the SMIs, as well as the types and charge of the mobility services provided by each tangrhub. This allows for greater control of the variables involved in the experiment, thus giving more emphasis to the contribution of the actual distribution of mobility resources among tangrhubs.

The following sections are meant to provide more insights on both the chosen urban area; its population; and the configuration of the smart mobility initiatives investigated in the paper in terms of mobility resource distribution and charges.

### Ascoli Piceno: the urban road network with tangrhubs

As a common testbed for all the SMIs investigated we chose the city of Ascoli Piceno (Italy), a mid-sized town of 50K inhabitants. There are no particular reasons behind this choice apart from the fact that the authors of this report are more familiar with this urban environment.

Figure 1 shows the portion of urban road network used for the experiment; it covers an area of about 15 $Km^2$ and includes both the main residential and commercial areas of the city. Moreover, the city centre is located westward and it is worth mentioning that the consistent and numerous traffic limitations imposed within this area have a tremendous effect on those citizens who cross it. Besides the urban road network, Figure 1 also reports the location of the tangrhubs as red triangles. Both the number and the actual placement of the tangrhubs considered for the experiment, were obtained from a cluster analysis tool provided by Tangramob and better detailed in [3]. In short, this tool tries to push a variable number of tangrhubs towards the activities of commuters (e.g. home, work, shopping), thereby minimizing the mobility to and from tangrhubs (first and last mile trips), also known as micro-mobility.

Considering the scarce availability of fine-grained data on the mobility behaviour of Italian commuters, the population used for the experiment was synthesized from a set of local statistical indicators (courtesy of ISTAT). In particular, the generation process of the synthetic population is detailed in [3] and it is based on statistical data as follows: 57% male and 43% female; the minimum and maximum daily working hours are 5 and 9 respectively. Finally, 15% of commuters leave home at 7 AM, 65% at 8 AM, 15% at 9 AM and 5% at 10 AM. Only commuters who can generate traffic are considered for the experiment.

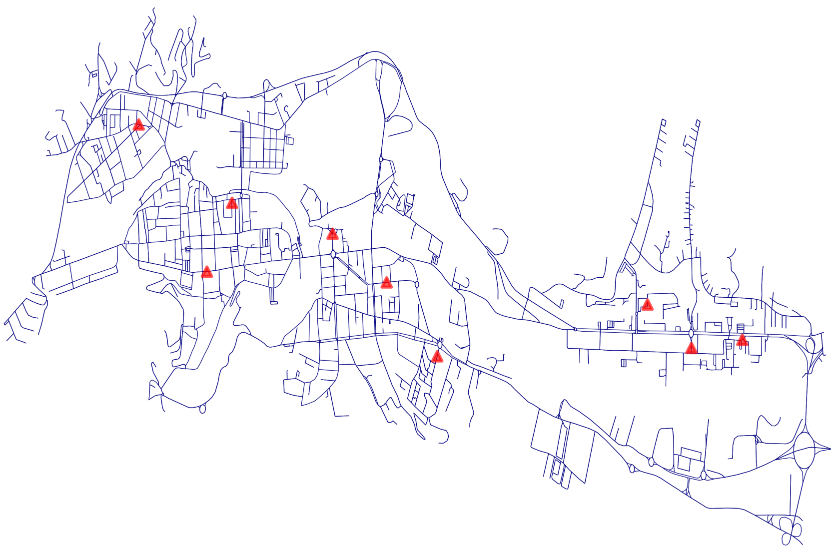

**Fig. 1.** Urban road network of Ascoli Piceno with tangrhubs

As similarly done in traffic simulations, the sample population is just a small yet representative portion of the whole population. Needless to say, this is done for speeding up the computation of the model. In our case, we found that a sample of 2068 commuters is still enough if the purpose is to capture the ordinary mobility patterns of the inhabitants of this part of Ascoli Piceno.

### Configuration of the investigated SMIs

The following tables show how the mobility services are configured for each SMI.

| | Cost per hour | Cost per km | Fixed Cost | Priority (only for ToolTRain) |
|---|---|---|---|---|
| Bikesharing | 0.5 € | 0 € | 0.01 € | 30 |
| Carsharing | 13 € | 0.1 € | 0.01 € | 40 |
| Scootersharing | 2.5 € | 0.1 € | 0.01 € | 35 |

**Table 1.** Cost and priority values per service

| | | light-SMIs | | | medium-SMIs | | | massive-SMIs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tangrhub | Service Type | SMI-1 | SMI-2 | SMI-3 | SMI-4 | SMI-5 | SMI-6 | SMI-7 | SMI-8 | SMI-9 |
| TH 0 | bikesharing | 0 | 2 | 2 | 2 | 2 | 4 | 5 | 10 | 25 |
| | carsharing | 2 | 2 | 6 | 2 | 4 | 4 | 5 | 5 | 25 |
| | scootersharing | 0 | 0 | 1 | 2 | 2 | 2 | 5 | 5 | 25 |
| TH 1 | bikesharing | 0 | 2 | 2 | 2 | 4 | 4 | 5 | 5 | 25 |
| | carsharing | 2 | 2 | 5 | 2 | 2 | 2 | 5 | 10 | 25 |
| | scootersharing | 0 | 0 | 1 | 2 | 2 | 4 | 5 | 5 | 25 |
| TH 2 | bikesharing | 0 | 3 | 3 | 10 | 10 | 10 | 35 | 35 | 25 |
| | carsharing | 3 | 3 | 4 | 5 | 5 | 7 | 30 | 20 | 25 |
| | scootersharing | 3 | 3 | 3 | 5 | 7 | 7 | 30 | 20 | 25 |
| TH 3 | bikesharing | 0 | 3 | 3 | 5 | 5 | 5 | 10 | 10 | 25 |
| | carsharing | 2 | 2 | 3 | 3 | 3 | 5 | 10 | 15 | 25 |
| | scootersharing | 0 | 2 | 2 | 3 | 5 | 5 | 8 | 8 | 25 |
| TH 4 | bikesharing | 0 | 0 | 2 | 5 | 5 | 5 | 10 | 20 | 25 |
| | carsharing | 0 | 2 | 3 | 3 | 3 | 5 | 15 | 15 | 25 |
| | scootersharing | 2 | 2 | 2 | 3 | 5 | 5 | 15 | 15 | 25 |
| TH 5 | bikesharing | 0 | 2 | 2 | 3 | 5 | 5 | 5 | 5 | 25 |
| | carsharing | 2 | 2 | 3 | 2 | 2 | 2 | 5 | 10 | 25 |
| | scootersharing | 0 | 0 | 1 | 2 | 2 | 7 | 5 | 5 | 25 |
| TH 6 | bikesharing | 0 | 0 | 1 | 7 | 7 | 7 | 20 | 10 | 25 |
| | carsharing | 2 | 2 | 3 | 4 | 4 | 6 | 15 | 15 | 25 |
| | scootersharing | 0 | 2 | 2 | 4 | 6 | 6 | 20 | 15 | 25 |
| TH 7 | bikesharing | 0 | 2 | 2 | 5 | 5 | 5 | 15 | 15 | 25 |
| | carsharing | 2 | 2 | 3 | 4 | 6 | 6 | 15 | 10 | 25 |
| | scootersharing | 0 | 0 | 2 | 5 | 5 | 7 | 15 | 15 | 25 |
| TH 8 | bikesharing | 0 | 0 | 2 | 5 | 5 | 5 | 10 | 10 | 25 |
| | carsharing | 2 | 2 | 3 | 3 | 3 | 5 | 10 | 15 | 25 |
| | scootersharing | 0 | 2 | 2 | 3 | 5 | 5 | 10 | 10 | 25 |
| total fleet | | 22 | 44 | 68 | 101 | 119 | 140 | 338 | 333 | 675 |

**Table 2.** The investigated smart mobility initiatives (SMIs)

As we can see from Table 1, just like in Tangramob, each type of mobility service comes with a charge that is computed as the sum of 2 travel-dependent factors, i.e. travel time and travel distance, plus a fixed contribution (e.g. cost of subscription or membership). In contrast, in order to approximate the ad-personam iterative learning process of the simulator, a prioritization schema for mobility services is introduced in the TRebeca reference model. In particular, the higher the priority value of a service, the more likely is the commuter to choose that service if it is available at a tangrhub. Therefore, for simplicity reasons, we set these values in order to reflect the expected traveling experience of mobility services in terms of comfort and speed. Although this kind of abstraction might make sense in a general context, it is worth observing that we cannot expect a car to always be more efficient in performing a trip; for instance, commuters traveling within the city centre of Ascoli Piceno may find the bicycle as a far better means of transport, due to traffic limitations.

Finally, Table 2 reports the full configuration of each smart mobility initiative in terms of vehicle distribution per service.

## References


1. Timedrebeca example page of tangramob, `https://goo.gl/HBacfs`
2. Castagnari, C., de Berardinis, J., Forcina, G., Jafari, A., Sirjani, M.: Lightweight preprocessing for agent-based simulation of smart mobility initiatives. LNCS Workshop Proceedings of SEFM 2017
3. Castagnari, C., De Angelis, F., de Berardinis, J., Forcina, G., Polini, A.: Tangramob: an agent-based simulation framework for validating smart mobility solutions, `https://www.tangramob.com/docs/SmartHub_Thesis.pdf`