Interactive simulation of inertia created by mobility habits

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1 Introduction

Recent years have seen an increase of public awareness of global warming, and their expressed concern about ecology. A well-known field of action for reducing one's carbon impact is mobility, where the impact of individual cars is well-known [8]. In line with public concern, institutions at the national or local level have been trying to encourage bicycle commuting to reduce traffic and pollution, via financial incitations or new infrastructures. These public policies result in increasing difficulties for car drivers (low emissions zones, urban tolls, petrol price, pedestrian areas, car parking difficulties, traffic jams, etc) and increasing comfort and safety for cyclists thanks to dedicated facilities [9]. Despite these changes, mobilities evolve very slowly, for instance in France a large proportion of commuting is still done by car, even for very short journeys [5]. The role of habits was already shown [4, 7]: individuals routinely reproduce their usual decision when they are in a similar context, which can save decision time but might also lead to misadapted decisions when the environment evolves. Changes in individuals' life cycles are thus the best opportunity to change their habits. For instance [2] have done an experiment where they tried to incite usual car drivers to adopt public transport, by giving them a free ticket when they moved to a new residence. The COVID-19 pandemics also showed an unusual reset of our habits and encouraged cycling, at least for a limited time [3]. We propose here a simulator of the dynamics of mobility in an evolving urban context, under the influence of habits. It is implemented in Netlogo [10] and playable online.

2 Simulating habits

2.1 Conceptual model

Our model[1] is based on a previous agent-based model of rational mobility choice [6] but is very simplified, considering only 2 mobility modes (bicycle and car) and one choice criterion: how favourable the town infrastructure is to this mode. It is considered here that space is limited so favouring one mode is necessarily

* Supported by the French National Research Agency (ANR), project SWITCH.
[1] A more detailed description can be found in [1].

at the expense of the other: dedicating more space to bicycles neccessarily takes this space away from cars, and vice-versa. As a result we represent the town infrastructure as a continuous value between 0 (entirely favourable to cars) and 100 (entirely favourable to bicycles).

Citizens are modelled as agents with a very simple behaviour: at each step (one day), they choose a **mobility** mode and move around with it. They store a **history** of the mobility mode used each day over their past 20 trips (this value is configurable in the code). This sliding window will be used to compute their habits, once it has reached the minimal length; before that it is considered that the citizen has no habit yet. Citizens can choose their mobility in 2 ways. **Rational** decision consists in using the rational mark (urban setting) as a probability, which ensures that the most favoured mode is chosen more often but still with some inter-individual variability; initially citizens can only choose rationally until they build habits. **Routine** decision consists in using the frequency of each mode in past history (once long enough) as a probability to reuse this mode. Over time, the agent's habits might strengthen, giving them more probability to decide routinely than rationally. Citizens also have a level of **satisfaction** equal to the rational evaluation of their current mobility mode. We expect that rational deciders switch mode when needed so stay mostly satisfied, while routine deciders might keep their usual mode even if not optimal anymore, so could grow very dissatisfied before they manage to reset their habit.

2.2 Simulator interface

The simulator[2] allows the user to modify urban planning at runtime, toggle habits on or off, and reset them. The interface (see Figure 1 provides feedbacks for these actions. Citizens move around in a window, their shape (bicycle or car) indicates their mobility mode, and their colour indicates their satisfaction (gradient from red - dissatisfied, to green - satisfied). Three plots allow to visualise the evolution over time of the modal distribution of citizens, their mean happiness, and the proportion of happy and unhappy citizens among users of each mode. Monitors also display the average strength of bike habit and car habit among their users, and the number of routine vs rational deciders.

2.3 Example scenario

If we start the simulation in a town initially very favourable to cars, without habits, most agents use the car and are very satisfied with it. If gradually making urban planning more favourable to bicycles, the percentage of car users drops subsequently, and the average population satisfaction stays high, since unhappy citizens will rationally switch mode.

If we now start over with the same urban setting but enabling habits, and let citizens build a strong habit, things are different. When gradually turning the

[2] https://nausikaa.net/wp-content/uploads/2023/01/habits-mobility.html

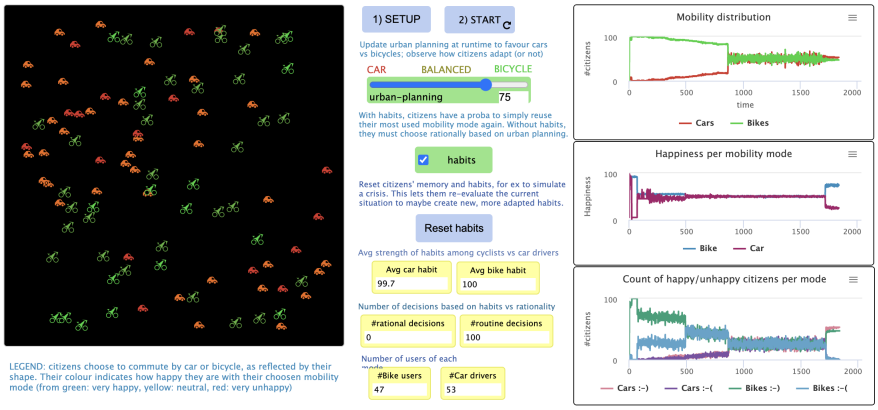

Fig. 1. Habits simulator interface: world (left), actions (middle) and plots (right)

town more favourable to bikes, citizens do not adapt: they follow their habits and keep using their car, despite their satisfaction dropping.

Finally, from that point in time, we can use the button to simulate a crisis and reset all habits. As a result, citizens immediately reassess their mobility rationally, *i.e.* based on urban setting. They subsequently switch to the most favoured mode, which is now bicycle, and turn satisfied again.

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