Impact of attentional factors in a multi-agent traffic simulation

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The road network includes in two kind of road sections: straight lanes, and road crossings. For road crossings, Mandiau *et al.* [1] proposed an algorithm derived from the game theory, where a driver decides at each time step to GO or to STOP depending on his evaluation of the relative priorities with the other players he selected in the "game". The GO/STOP decision is then translated into an acceleration for the driver's vehicle. We will investigate the impacts of the change of two parameters which are fixed in their model [1]: the distance d from the road crossing and the limited number R of other drivers.

1 Model

A road traffic simulation was implemented using Repast. Drivers are autonomous agents, their behaviors consist of a car-following model [2] and a conflict solving model [1] which begins at a distance d from the crossing itself.

The present paper discusses two aspects (Anticipation, Cognitive resource) of the psychological model which is used to implement the driver behavior.

Our starting points are the following:

- The cognitive cost of driving in a "car following" mode is far less than driving in a "road crossing" mode;
- The number of events which are taken into account at the same time when performing a task impact the cognitive load relative to the task [3] (this may be related to the previous item);
- Above all, people prefer to lower their cognitive load when possible [4].

In the following, we present preliminary work showing how these behavioral constraint may be implemented in the case of an agent-based road traffic simulation, and how they impact the emerging behavior (accident rate and traffic flow).

The anticipation is implemented as a distance d from the road crossing, where the agents begin to consider they are on a crossing section, anticipating potential conflicts (we could as well have considered a temporal criterion). The limited cognitive resources are implemented as a limit in the number of the other drivers which are considered, when the driver resolves the STOP/GO problem at the crossing (the level of resource R may vary between 1 and 3). The agent selects the R more relevant players among these approaching agents (no more than one player may be selected on a given lane and among the preselected approaching drivers, only the nearest R

are selected as players). Note that the selection of the players may be different for several players approaching a crossing, and that this selection is re-evaluated at each time step ($\Delta t = 0.1$ s in the following).

2 Results

To test the effects of attention parameters, traffic simulations were computed with different values of the anticipation distance d ($d = 10, 25, 50$ and 75 m) and various values of the maximum number R of selected players. The input flow and the probability that a vehicle turns right, left or goes ahead were taken from actual traffic data on a road crossing in Reggio Calabra, Italy [1]. For each value of (d,R), 14 simulations of one simulated hour were computed. The traffic output was recorded as well as the accident rate.

The first interesting result is negative: no strong effect of the anticipation distance d appears on the emerging behavior, either in terms of accident rate or in terms of traffic flow.

d	1	2	3
F	1919	1703	1673
$a10^3$	3.89	2.88	2.86

Table 1: Effect of the limited number of the other drivers R on the traffic flow F (in v/h) and on the accident rate a (in v^{-1}) on the simulated road crossing.

Nevertheless, the number of players impacts the emerging traffic and the accident rate (see Tab.1). They are dual, in the sense that lowering the cognitive load engaged by the drivers has two opposite effects: one positive, in terms of traffic flow, and thus in terms of individual rewards (shorter individual time travel). The negative effect (less striking however) is the higher risk level associated with this strategy. In short, it seems that this parameter could be individually tuned in order to replicate the variability in the driver's attitude towards risk taking.

3 Discussion and future work

We showed that the individual game strategy, in terms of number of selected players, has an impact on the macroscopic variables (flow and accident rate). That is, a lazzy strategy (lower number of players selected in the game) results in a more risky, together with a faster behavior.

Future work includes a quantitative model of the cognitive load, in order for each simulated driver to select the model's parameter (such as the number of players, the time when the game begins) in terms of its internal state (motivations, cognitive resources, risk-taking, etc.). An agent engaged in a multiple-player road crossing "game", with long term anticipation, increases the cognitive cost of the crossing. Thus, future work includes the optimization, for each agent, of the road crossing cost under temporal and safety constraints.

One of our objectifs is to investigate the interaction between pedestrians and drivers on a road crossing. To do that, we need a pedestrian model dedicated to the urban environments as in [5].

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