Traffic Simulation with an Organizational and Multilevel Agent-based Model

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Abstract.

Road traffic has many advantages for both nations and individuals. Traffic facilitates the movement of goods and people, provides access to markets, education, care, leisure and so on. Traffic is ubiquitous[SWL11] and it's a large scale phenomenon because it meets these criterias[SMMD14]: (i) traffic is composed by heterogeneous entities, (ii) The number of entities composing the traffic is very high and interactions between these entities are nonlinear, (iii) traffic is geographically and fundamentally a distributed phenomenon, (iv) there are several level of detail of traffic observation. Traffic is therefore a complex system because interactions between the entities are nonlinear and the collective behaviour of these entities is non-trivial.

The works presented in this abstract are devoted to overcome these shortcomings and lay the groundwork for the dynamic, organisational and holonic modelling of large scale road traffic that does not fixed a priori the different abstraction levels. The organisational approach allows to model complex systems like traffic and also allows to define several levels of abstractions of the system. Its strengths are modularity, multiple architectures, heterogeneity of languages and application safety. Organisational approach facilitates holonic modelling through the modularity and reuse of models. A holon [Koe67] is simultaneously a whole and a part of the whole, thus it can be made up of other holons, strictly meeting three conditions: being stable, having a capacity for autonomy and being able to cooperate.

Vehicles communicate by stigmergy. Each couple driver-vehicle is an agent. Fig. 1 shows the organizational model of the system, the environment, and the conveying agents. Two roles are defined: `Vehicle` and `Environment`. The `Vehicle` role is responsible for simulating the behaviour of a single vehicle or a group of vehicles while the `Environment` role gives a vehicle the means to perceive and to move in

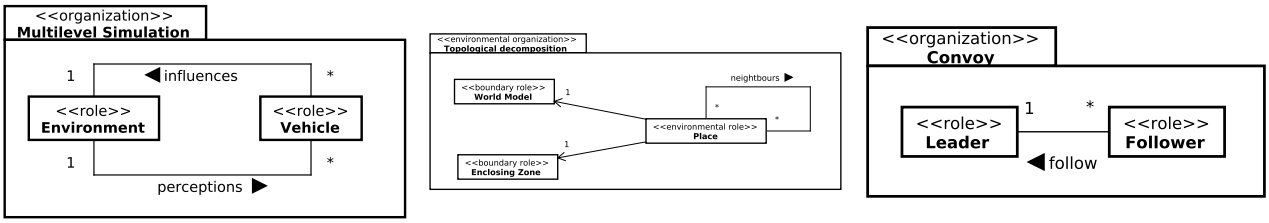

Figure 1: Organizational Models: System (left), Environment (center), Convey (right)

the simulated universe. Vehicles tend to regroup in convoys when approaching an heavy vehicle or when the road becomes jamed. These spontaneous convoys born from vehicle interaction as an emerging phenomena. The vehicles in spontaneous convoy can therefore form the organization `Convoy`.

Different levels of abstraction are considered for the role `Vehicle`. The most precise level is the microscopic level: a vehicle is associated with a holon. Each vehicle goes from an origin to a destination. At the higher level, named mesoscopic, each super-holon simulates the behaviour of a vehicle group. The group is considered as a "virtual" vehicle with its own right and need to define the new characteristics from its members. The self-similarity of the holons makes it possible to use the same role `Vehicle` at all the levels of abstraction, and this for each holon. The model that describes the behaviour of the vehicles must be self-similar (or recursive), that is, it must be able to adapt for both individual behaviour and collective behaviour.

When a driver wants to move, he leaves an origin to a destination. Its objective is therefore to reach its destination. In order to effect a holonic decomposition of vehicles, it is necessary to ensure coherence between regrouping vehicles. To achieve a holonic decomposition of the vehicles, it is necessary to ensure the consistency between the groupings of the vehicles. Vehicles have a goal: to reach their destination. This objective can be decomposed into a series of intermediate sub-objectives which are navigation from intersection to intersection until its destination. Based on [VKJB13], vehicles are grouped according to: (i) the traffic direction; (ii) the position on the road; (iii) the distance between vehicles; (iv) the speed difference between the leader and the follower.

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