

Modeling Carpooling : a Brief Literature Review

Working Paper

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Date

Abstract

Multi-agent Modeling and Simulation of Carpooling [Galland et al., 2013] : description of platform architecture. [Galland et al., 2014] : more details on implementation.

Co-routing Problem

Biological Agent-based Modeling of Collective Action A crucial point that should be tackled by our modeling approach is the notion of “critical mass”, i.e. intuitively the typical number of users giving an optimal performance (in the Pareto sense, depending on indicators defined) for the carpooling systems. One can take an abstract viewpoint and understand it in a game-theoretic formulation, where agents take decision on their behavior to the carpooling system in a game. Analogy with biological systems is immediate through abstraction, what allow the use of advanced modeling techniques developed in the field. An abstract model, proposed in [Pacheco et al., 2015], includes the notion of quorum signalling in a game-theoretic model with an arbitrary number of agents (that can be bacteria, humans, etc.). The quorum corresponds to our notion of critical mass, and it is proven that communication between agents and the system (signaling) allows the emergence of a collective action without top-down coordination. It suggests that bottom-up measures may have a powerful effect on overall system behavior and must therefore be considered for integration in the modeling process.

Statistical Analysis Data analysis is relevant for an understanding of spatialized use patterns of a car-pooling system, but may be necessary for a modeling approach, for example in the case of a data-driven model which needs precise parametrization from statistics on real data. The influence of factors at various levels (worksite level, company level, economic sector level) may be desirable to integrate in a generic model, and one thus needs to empirically understand each role. In [Vanoutrive et al., 2009], a multi-level modeling approach is used on Belgian commuting data, which reveals significant influence of the economic sector, whereas no significant results on the influence of employer-level carpooling promotion (what is interesting to our question) were found.

References

[Galland et al., 2013] Galland, S., Gaud, N., Yasar, A.-U.-H., Knapen, L., Janssens, D., and Lamotte, O. (2013). Simulation model of carpooling with the janus multiagent platform. *Procedia Computer Science*, 19(0):860 – 866. The 4th International Conference on Ambient Systems, Networks and Technologies (ANT 2013), the 3rd International Conference on Sustainable Energy Information Technology (SEIT-2013).

- [Galland et al., 2014] Galland, S., Knapen, L., Gaud, N., Janssens, D., Lamotte, O., Koukam, A., Wets, G., et al. (2014). Multi-agent simulation of individual mobility behavior in carpooling. *Transportation Research Part C: Emerging Technologies*, 45:83–98.
- [Pacheco et al., 2015] Pacheco, J. M., Vasconcelos, V. V., Santos, F. C., and Skyrms, B. (2015). Co-evolutionary dynamics of collective action with signaling for a quorum. *PLoS Comput Biol*, 11(2):e1004101.
- [Vanoutrive et al., 2009] Vanoutrive, T., Van Malderen, L., Jourquin, B., Thomas, I., Verhetsel, A., Witlox, F., et al. (2009). Carpooling and employers: a multilevel modelling approach. *proceedings of the BIVEC-GIBET Transport Research Day. Brussels, VUBPRESS*, pages 335–349.