Thesis proposal: multi-agent simulation for decision support in the context of urban logistics

The Centre for Robotics Mines Paris - PSL and the Department of Computer Science and Intelligent Systems at Mines Saint-Etienne propose a PhD thesis on the design, implementation, and validation of a multi-agent simulation tool for decision support in the context of urban logistics. This project is funded by the Mines Paris Urban Logistics Chair.

Context

Urban logistics, or the transport of goods in the city, brings together the diversity of traditional supply chain players operating in a constrained environment (e.g., congestion, regulatory standard on engines, lack of delivery area, etc.). Urban logistics also mobilize other actors such as the State or local authorities responsible for regulating the freight transport. These actors have at best imperfectly aligned interests and goals. While the supply chain actors adapt their operations to achieve their strategic objectives (e.g., reduce the delivery time and costs), the regulators adapt the regulations to improve the usage of the common goods (e.g., reduce pollution and congestion).

Thesis topic

Considering urban logistics as a Complex Adaptive System (CAS) (Choi et al., 2001), we will explore the issue of control and the phenomena of emergence resulting of the adaptation process of stakeholders of an urban logistics system. The modelling challenge of a CAS could be as follows: a decision made at a global level (e.g., the city) will have different effects at a local level (e.g., urban logistics sectors). For example, the ban on diesel engines may have a different effect depending on the carrier's activity (e.g., food or parcel delivery) and the alternatives available (length of rounds, loading capacities, etc.). Carriers would face several choices (e.g., electric or hydrogen, subcontracting, or external growth) to overcome this new constraint. From the perspective of the regulator, it creates uncertainty about the estimation of the effect of regulatory action on the common goods.

The challenge for decision-makers is to be able to anticipate the behaviour of a CAS to guide them in its decision-making by identifying variables capable of steering the system in towards their preferred direction. Following a bottom-up design approach, the multi-agent paradigm allows a modeling of the objectives, constraints and behaviors of the actors as well as their interactions and regulations.

The problem proposed in this thesis is the modelling, implementation and validation of a CAS that is specific enough to be realistic and that supports the emergence of

alternative behaviors. The expected result is a decision support system for economic actors or local authorities to evaluate the consequences of their decisions. In a second step, the research work resulting from multi-agent simulation should make it possible to explore the space of alternatives for the stakeholders, in other words, their strategies of adaptation considering changes in the system (e.g., after a new regulation).

Scientific and technical skills

- Modeling, Multi-Agent Simulation
- Programming: Java and Python
- Notions of supply chain management (optional)
- Good writing skills in French and English

Interpersonal skills

- Autonomy and curiosity
- Teamwork
- Rigour

Miscellaneous information

- Location: Paris and Saint-Etienne (short stay to be defined)
- Supervision: Arthur Gaudron, Gustavo Nardin, Flavien Balbo
- Application deadline: June 15, 2022
- Start: October 2022

Application file

- CV
- Cover letter
- Master Transcripts
- Letters of Recommendation
- Justification of research experience (Master thesis, internship in a research laboratory)
- Any other document room you deem useful

The application material should be addressed to arthur.gaudron@minesparis.psl.eu, luisgustavo.nardin@emse.fr, flavien.balbo@emse.fr

References

Choi, T. Y., Dooley, K. J., & Rungtusanatham, M. (2001). Supply networks and complex adaptive systems: Control versus emergence. *Journal of Operations Management*, *19*(3), 351–366. https://doi.org/10.1016/S0272-6963(00)00068-1