

Call for applications for Post-Doctoral

Determining organizational trajectories in agent-based systems: application to hospital emergency departments

Supervision:

JUNEAU project team

University: INSA Lyon & CHU Saint-Etienne

Research laboratory: DISP laboratory

Required profile:

Doctor in Industrial Engineering with a modelling and simulation dimension, experience with Hospital Engineering

Funding: JUNEAU project

Internship period: 1 year from November 1st 2022

Required skills:

process and data modelling (UML, BPMN), agent-based simulation

Key words: Digital Twin, agent, simulation, Emergency department

Topic description:

The ANR JUNEAU project, a partnership between the DISP and CRAN laboratories and Saint-Etienne University Hospital, aims to provide a Digital Twin for Emergency Department (ED) services. In order to improve the management of such a complex and highly dynamic system and thus improve patient care and treatment, it is necessary to propose new approaches that are as close as possible to decision-making.

In the current "Industry of the Future" dynamic, the Digital Twin (DT) approach is known to meet the need for management as close as possible to the system and also to better anticipate behavior through the integration of simulation and artificial intelligence [4,5]. The objective of the JUNEAU project is to explore this approach for EDs.

In order to ensure consistency between the two physical and digital twins, it is important to extract knowledge about the dynamics of the underlying organizations. This position explores this dimension.

Suggested work program:

An organization is a group of agents who interact and produce some form of result [1]. Formal organizations—such as businesses and governments—are generally created for an explicit purpose, even if that purpose is not necessarily shared by all members of the organization. An entrepreneur who starts a business may do so to generate personal wealth, but the workers they hire may have very different objectives. This highlights the fact that overall behavior is the result of each agent's decisions and interactions. The whole is organized to achieve the desired outcome. The concept of agents, and certainly a scientific approach based on agent-based modeling, provides a quantifiable and objective view of the organization. In particular, under this formalism, the authors define a hierarchy of control of the organization by looking at the state of the agents (workers, customers, or others) and constructing a geometric (sometimes abstract) representation of all these states [2,3]. This is what we will call the morphological representation of the organization. Then, through expert feedback, we can get an idea of performance and thus classify organizational morphologies to manage the system. It is also possible to go even further in organizational performance by having a very precise idea of the space of organizational morphologies [3] and constructing objective performance functions, thereby optimizing management [1].

Our study context is the pediatric emergency department at Saint Etienne University Hospital, a partner in the JUNEAU project. How this system is organized and what morphological representation we can propose to see its evolution over time are questions that need to be addressed carefully. The temporal evolution of morphologies will constitute trajectories, the evolution of which could give us an even broader idea of the possible organizations leading to better performance.

The work required will consist first of all in constructing the vector of states of each of the actors (patients, nurses, doctors, etc.) in the pediatric emergency department and quantifying the possible interactions. Next, a reflection will be conducted to define the appropriate organizational morphology (and its space) and then observe its evolution over time in order to determine occurrences (patterns). Tests (agent modeling) may be performed on systems with fewer agents in order to validate hypotheses and infer performance.

Références :

[1] Chang, M.-H., & Harrington, J. E. (2006). Agent-based models of organisations.
[https://doi.org/10.1016/S1574-0021\(05\)02026-5](https://doi.org/10.1016/S1574-0021(05)02026-5)

- [2] Campagne, J., Cardon, A., Collomb, E., & Nishida, T. (2004). Massive multi-agent systems control. 3rd NASA/IEEE Workshop on Formal Approaches to Agent-Based Systems (FAABS-III).
- [3] Cardon, A. (2004). Etude de la conception et du contrôle comportemental d'une organisation massive d'agents. <http://admiroutes.asso.fr/larevue/2001/22/Robot.pdf>
- [4] Bouleux, G., El Haouzi, H. B., Cheutet, V., Demesure, G., Derigent, W., Moyaux, T., & Trilling, L. (2022, September). Requirements for a digital twin for an emergency department. In International Workshop on Service Orientation in Holonic and Multi-Agent Manufacturing (pp. 130-141). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-24291-5_11
- [5] Florencia, J., Moyaux, T., Trilling, L., Bouleux, G., & Cheutet, V. (2024). Toward Improving Dynamic Resource Scheduling in the Context of Digital Twin of Emergency Department. IEEE Transactions on Automation Science and Engineering. <https://doi.org/10.1109/TASE.2024.3463489>

Submit your application by August 30, 2025, by sending an email to vincent.cheutet@insa-lyon.fr and guillaume.bouleux@univ-st-etienne.fr. Precise the job offer reference (DISP-2025A) and attach a folder composed of the CV, 2-3 scientific publications, PhD summary and PhD reviewer reports.