

MADRAS meeting

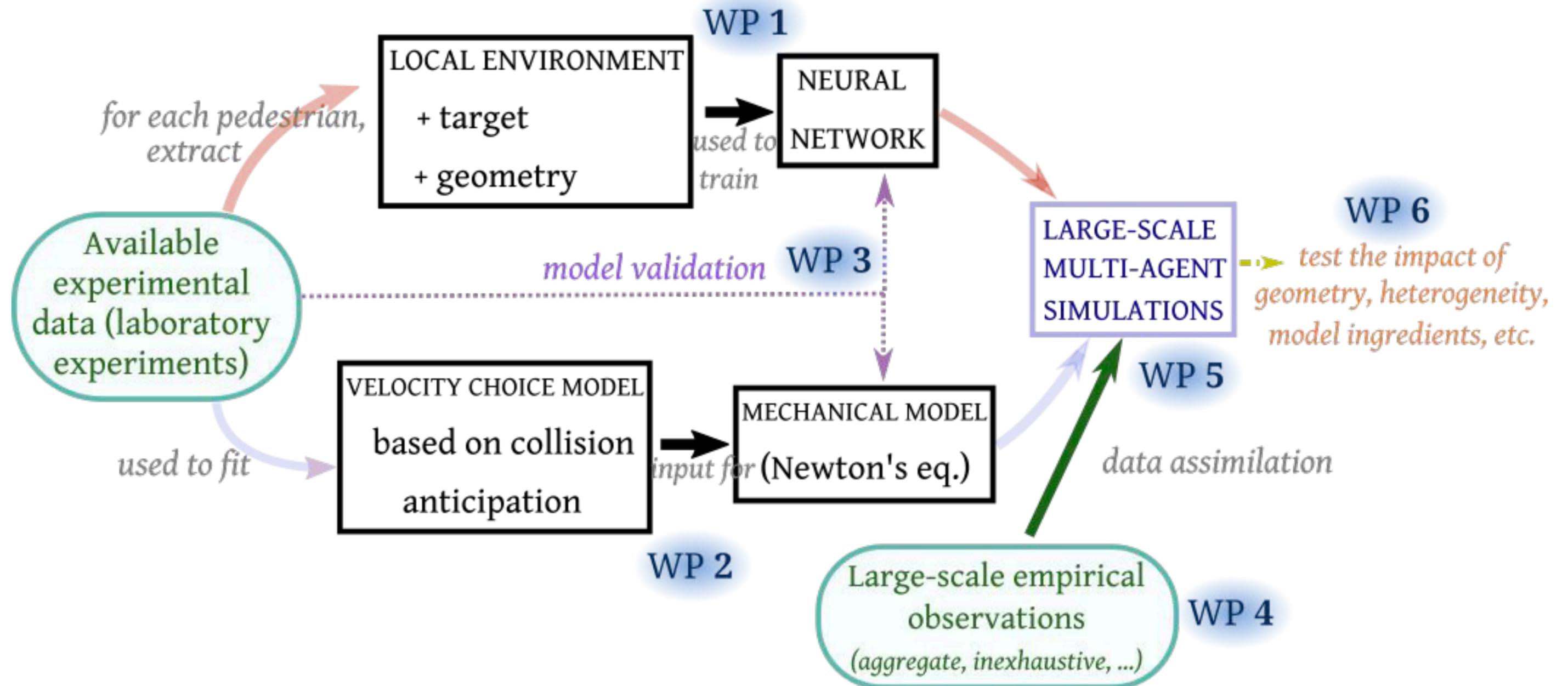
Benoit Gaudou, July 9th 2021

MADRAS meeting

General information

- New participants
- Extension of the project to end December 2024 (to cover all the PhD funding):
 - ➡ Accepted by ANR
- The fete des lumières (<https://www.fetedeslumieres.lyon.fr/>): Wed. 8 to Sat. 11 of December 2021.
 - Week between 13 to 17 of December: possible week for MADRAS meeting
- Visit of Phd students? 3-months visit in other labs.
- Jacob's and Raphael's current work (in a few minutes)
- Presentation of WP5

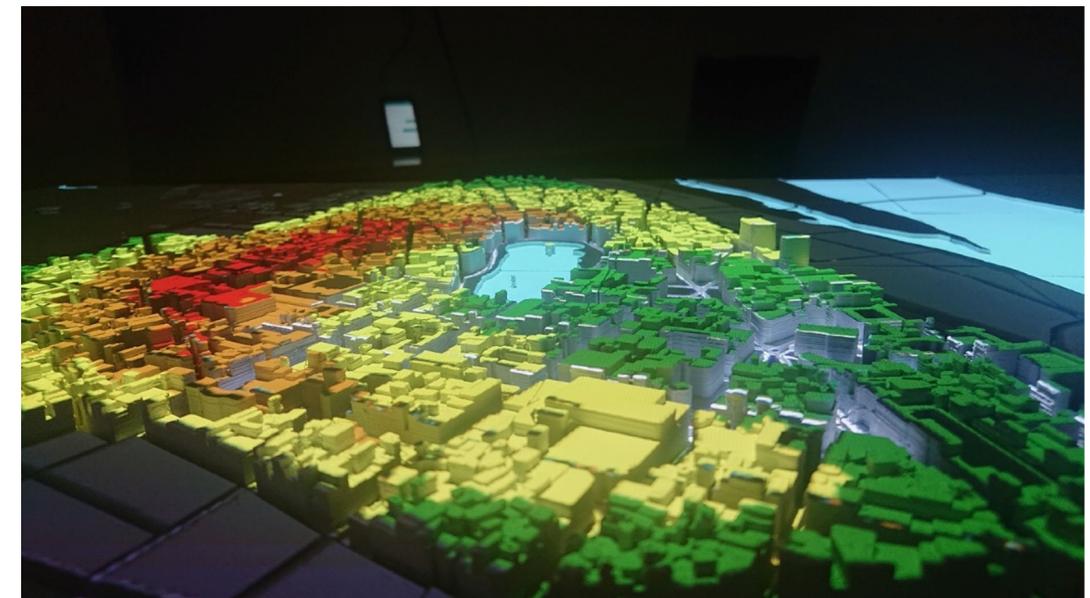
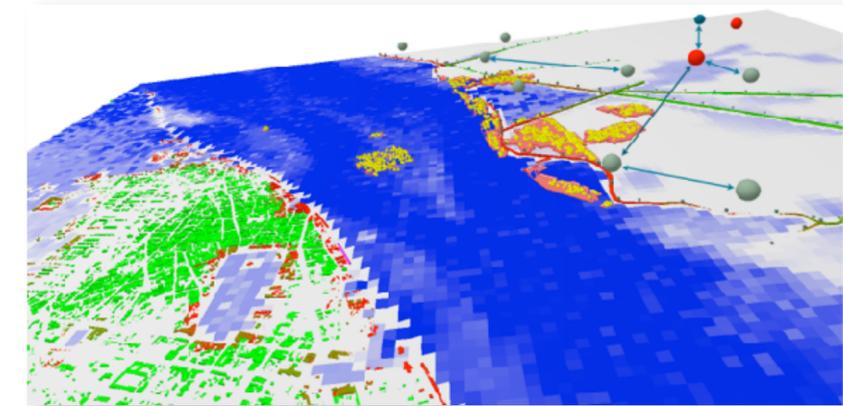
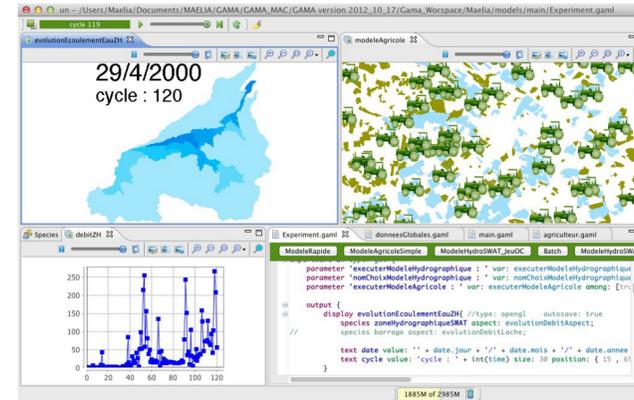
Reminder of the project structure



SMAC team

- **Agent-based modelling and simulation of complex socio-environmental systems.**
 - ➔ Complex agents behavior in simulation (reasoning and decision, impact of emotions on behaviors ...)
 - ➔ Multi-modeling : math +/-vs agents
 - ➔ Synthetic population generation

- The GAMA platform
<http://gama-platform.org/>



Preliminary insights from preliminary literature review

- Web Of Science search for: pedestrian crowd agent-based model
 - ➡ Pedestrian/crowd model inside a "bigger" model: e.g. evacuation, disease spread...
 - ➡ Most of the papers are not focused on individual pedestrian modelling. The focus is rather on social group, individual decision-making (when and where to evacuate, impacts of other criteria...).
 - ➡ Social Force Model remains the reference model for individual moves. [Helbing et al. 1995]
 - ➡ Density ???

Review papers on Pedestrian Evacuation Simulation (PES)

- *Chen, J., Shi, T. and Li, N., 2021. Pedestrian evacuation simulation in indoor emergency situations: Approaches, models and tools. Safety Science, 142, p.105378.*
 - ➡ The use of **high-fidelity PES** approaches has become more prevalent over time.
 - ➡ The adaptability of PES models to different evacuation scenarios is limited.
 - ➡ Human behavioral mechanism modeling is the driving force for PES model advancement.
 - ➡ Verification and validation are the major challenges for PES tools.

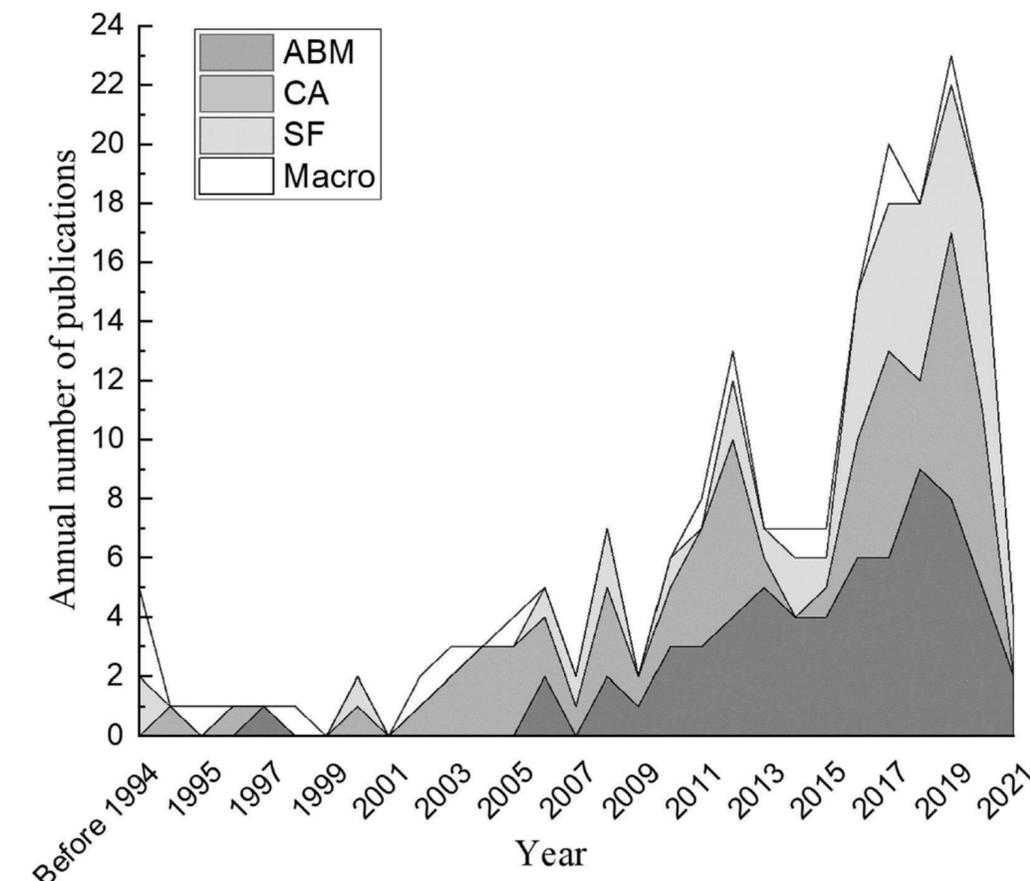
Review papers on Pedestrian Evacuation Simulation (PES)

➔ [Chen et al., 2021] makes a distinction between **Social Force Models** (, Cellular Automata) and **Agent-Based Models**:

- **SFM**: based on Helbing's SFM, **extended with other forces**: attractions from exits, heterogeneous forces between leaders and followers, group forces.
- **ABM**: focusing on adding **emotions** (and other individual features, e.g. BDI architectures) in the modelling of **individualized and heterogeneous decision-making** process and **social behaviors**, such as **following a leader, waiting and searching for group members, and helping others**, enriches the **behavioral space of individuals** in the model.

➔ Agent-Based models when "individuals are autonomous agents that have their own characteristics and behaviours and act according to the situation encountered in the environment".

➔ Density mainly in CA models



Review papers on Agent-Based PES

- *Siyam, N., Alqaryouti, O. and Abdallah, S., 2019. Research issues in agent-based simulation for pedestrians evacuation. IEEE Access, 8, pp.134435-134455.*

➔ Main purpose:
Human behaviour

➔ Main validation method:
not specified or
qualitative validation

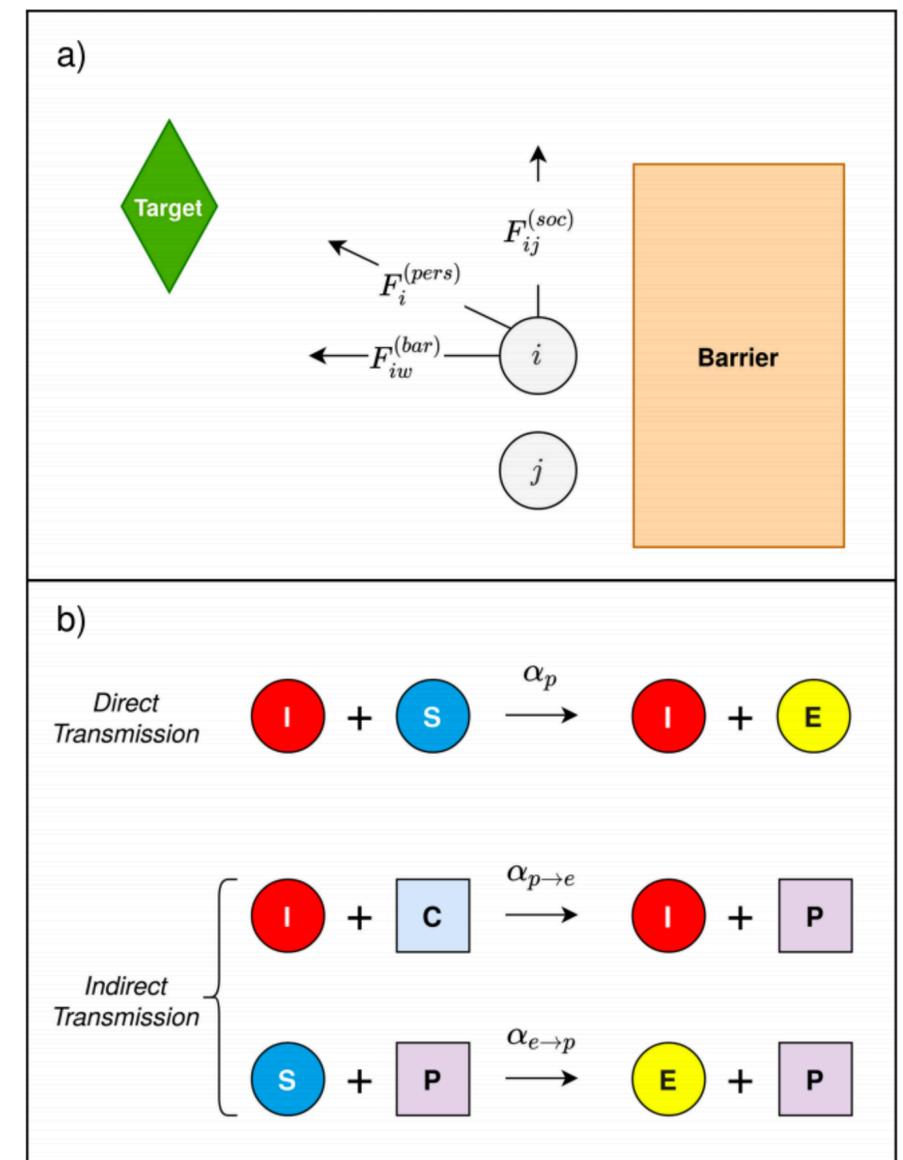
	Simulation Purpose		Emergency Type		Type of Building		Simulation Technology		Evacuation Policies		Psychological & Physical Characteristics		Validation Method	
	Icon	Text	Icon	Text	Icon	Text	Icon	Text	Icon	Text	Icon	Text	Icon	Text
Number of Surveyed Papers		Human Behavior		General		Building		Other		Leader / Follower		Information Share		None Mentioned
		Building Structure		Fire		Room		Not Discussed		Evacuation Instructions		Groups and Families		Qualitative
		Evacuation Plans		Earthquake		City		NetLogo		Authority Agents		Stamina / Injured Agents		Against Real Scenario
		Evacuation Strategies		Tsunami		Flat Area		AnyLogic		Announce on Evacuation		Psychological Model		Against Data
		Evacuation Model		Flood		Subway		GAMA		Trained Agents		Stress and Panic		Against Verified Models
		Others		Blast		Stadium		Visual Studio		Rescue Agents		Waiting Time		Expert Opinion
		Fire Evacuation		Wildfire		University		Visual C		Delayed Evacuation		Help Injured		
						Building Floor		PULSE				Disabled		
					Museum		Path Finder							

Most of the models use/extend Social Form Model

- *Sajjadi, S., Hashemi, A. and Ghanbarnejad, F., 2020. Social distancing in pedestrian dynamics and its effect on disease spreading. arXiv preprint arXiv:2010.12839.*

➔ "Extension" of the social force to take into account social distancing.

➔ Results depending on the density (2 densities, allowing social distancing) on the disease spread.



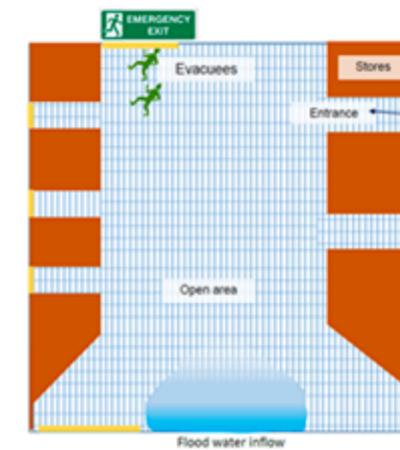
Most of the models use/extend Social Form Model

- *Shirvani, M., Kesserwani, G. and Richmond, P., 2020. Agent-based modelling of pedestrian responses during flood emergency: mobility behavioural rules and implications for flood risk analysis. Journal of Hydroinformatics, 22(5), pp.1078-1092.*

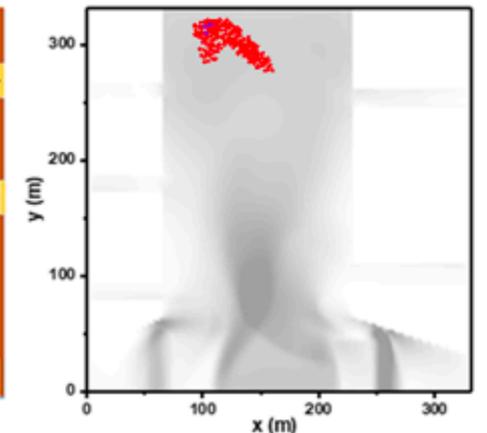
➡ FSM model in dry environment, with various modes (speed depending on Hazard Risks and body heights/weight + stability).

➡ Results in terms of people exposition to risk

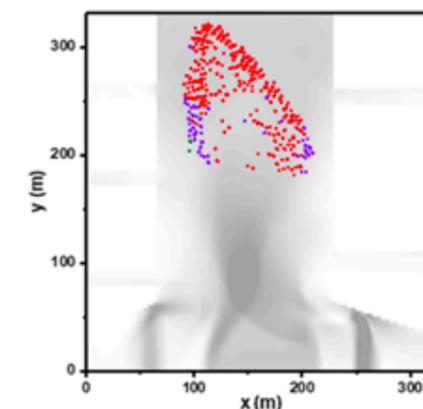
Evacuation simulation:



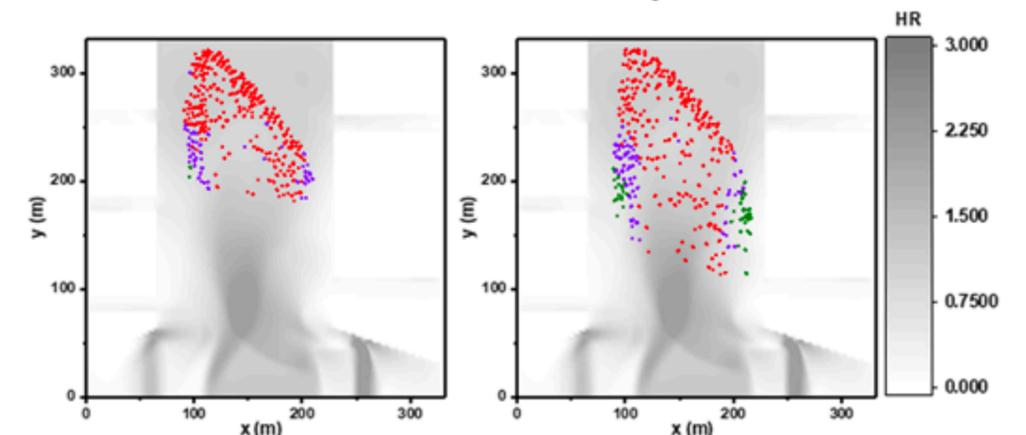
Without variable walking speed and stability



With variable walking speed



With variable walking speed and stability



Some exceptions

- *Kleinmeier, B., Köster, G. and Drury, J., 2020. Agent-based simulation of collective cooperation: from experiment to model. Journal of the Royal Society Interface, 17(171), p.20200396.*

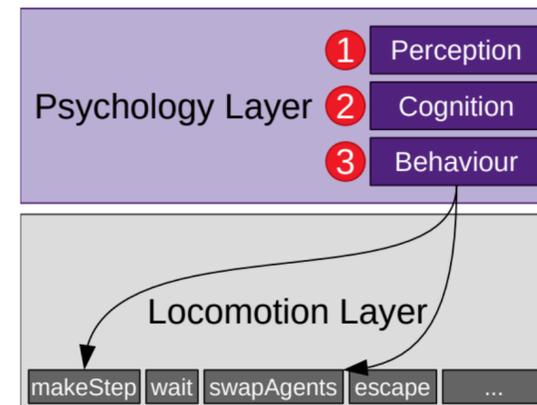
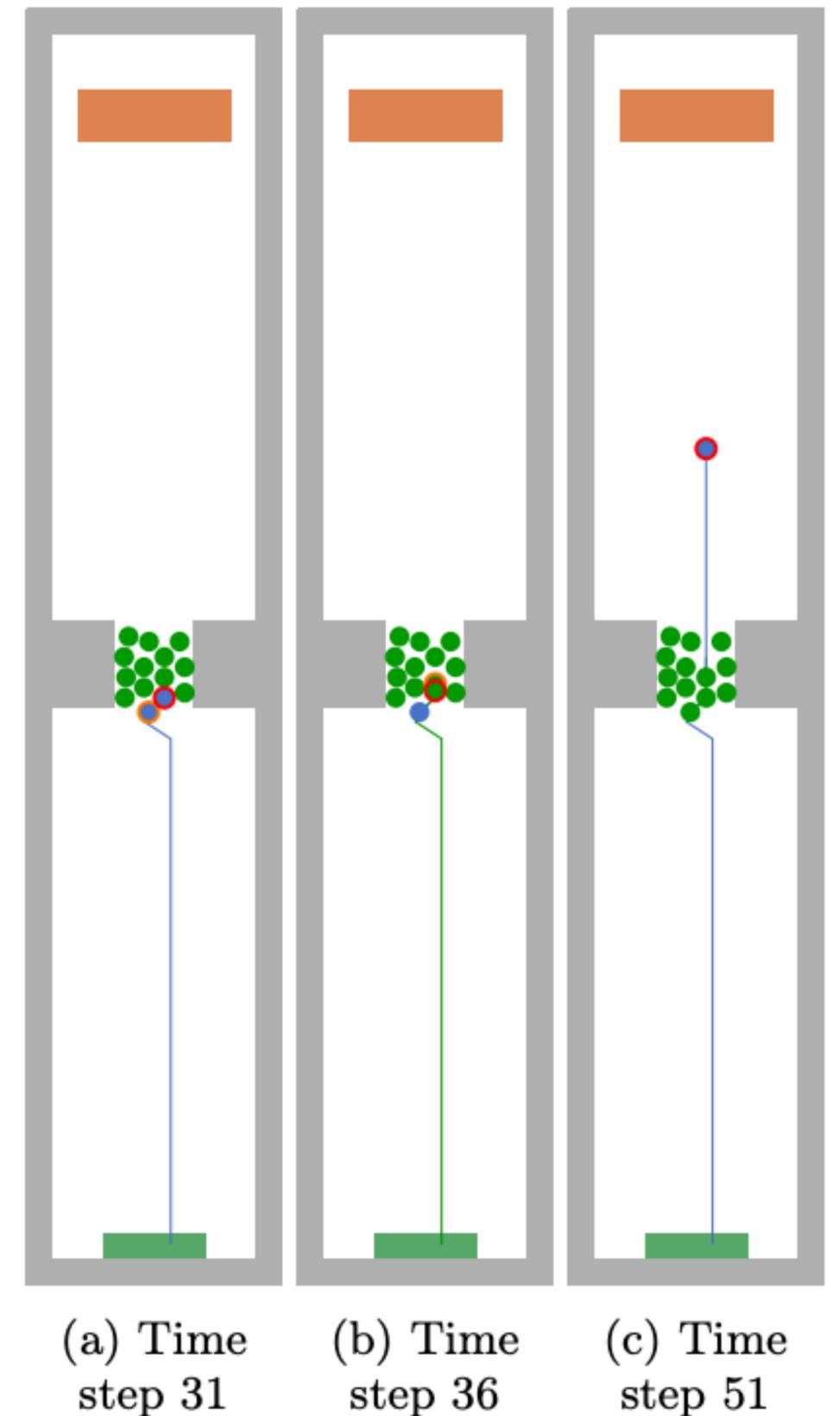


Figure 11: The three sequential phases of the new psychology layer: Firstly, agents perceive environment stimuli. Secondly, agents process these information in cognition phase and enrich it with further (context-relevant) information. Thirdly, agents react to the processed information by selecting a behaviour from a behavioural repertoire on locomotion layer. The behaviour repertoire on locomotion layer should cover different real-world situations. For instance, make a step towards a target (e.g., a train station), wait at a platform (that is, do not move) or escape from a bang stimulus (which consists of several locomotion patterns



Previous works done in the SMAC team

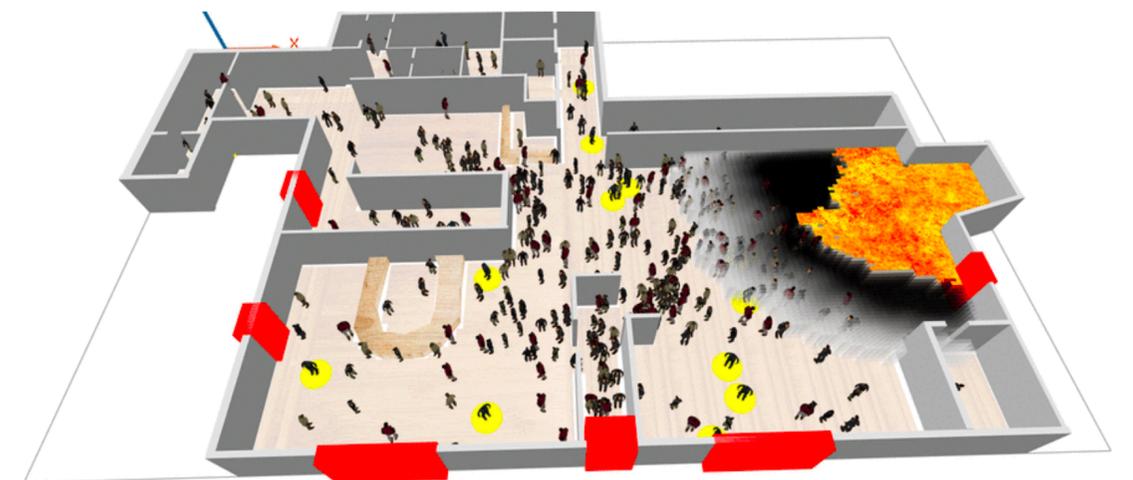
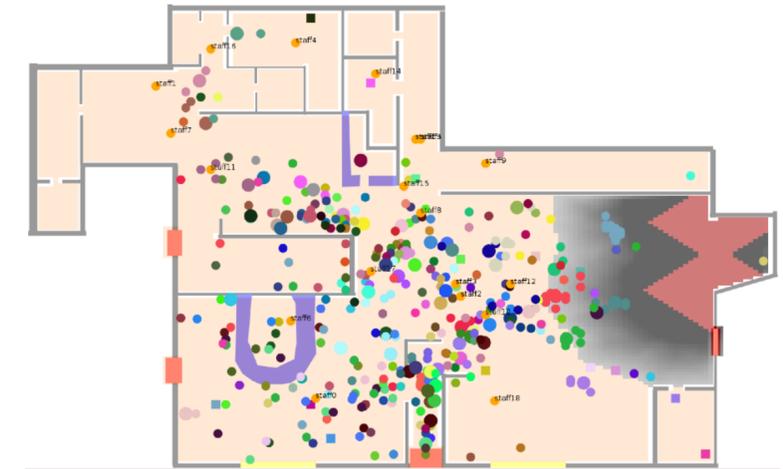
Simulation of the evacuation of the Station Night club (facing fire and smoke).

Agents are heterogeneous:

Staff: providing information

Customers: evacuate taken into account their knowledge about exits, emotions, their social group...

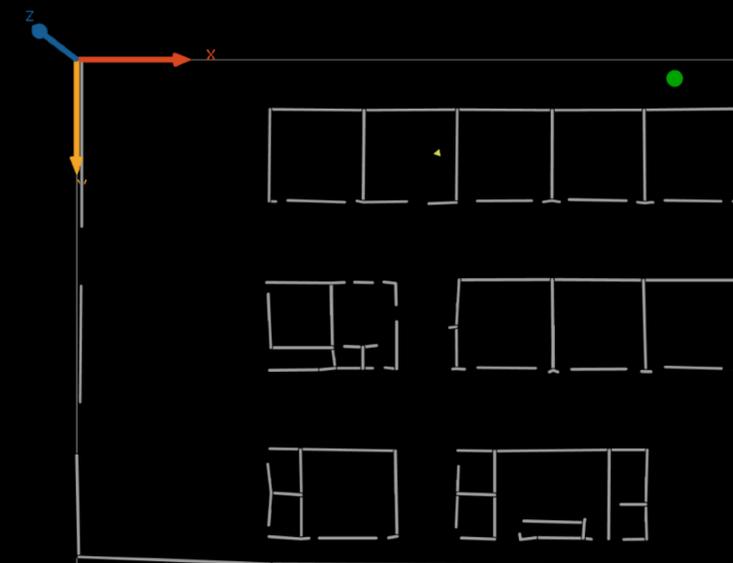
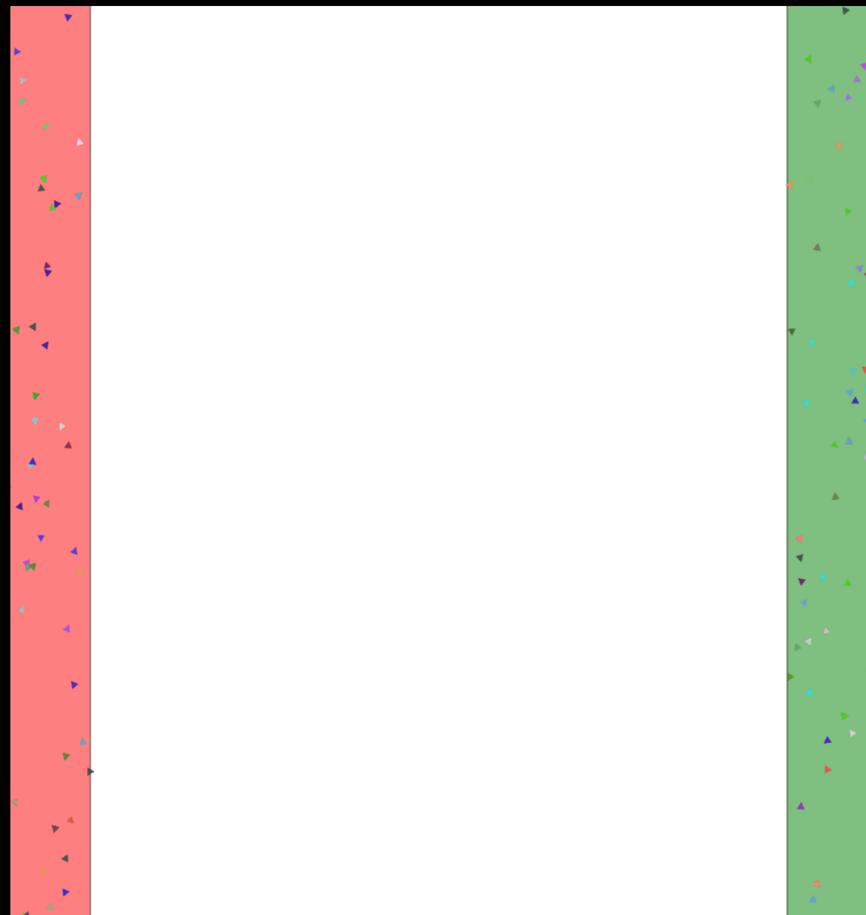
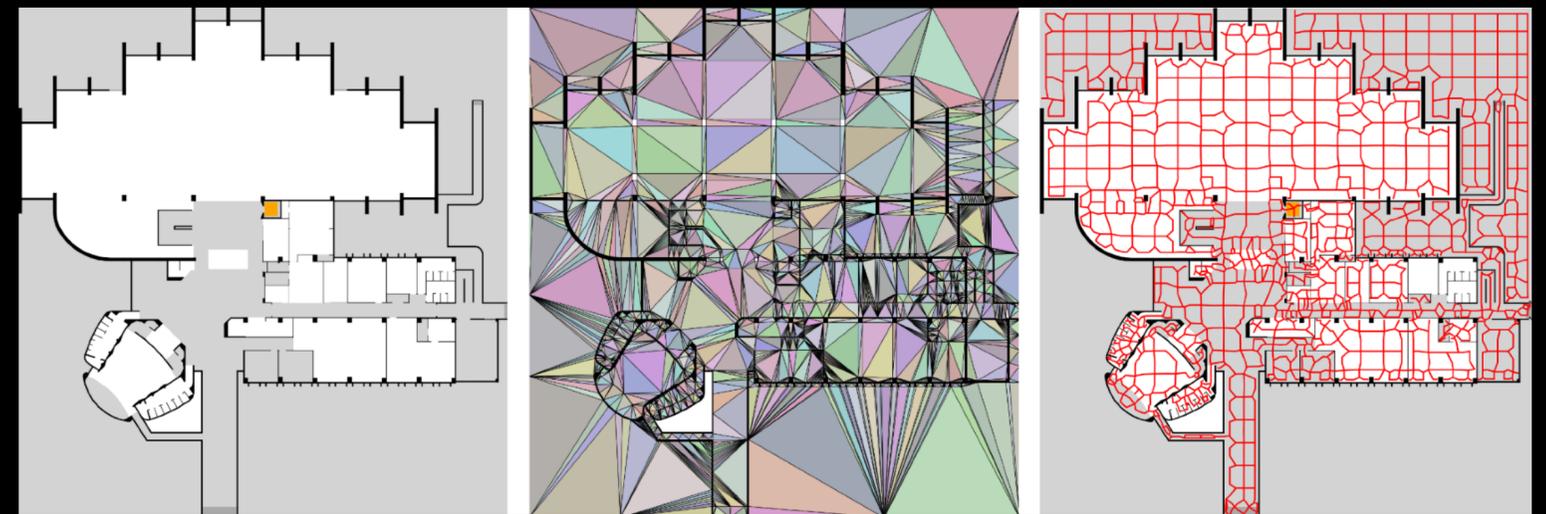
Assessment/validation: number of evacuees, distribution of evacuees in each exit.



GAMA 1.8.2: NEW PEDESTRIAN SKILL

Includes:

- ➔ Pedestrian avoidance capabilities using SFM (Helbing)
- ➔ Possibility to build path from polygons



PhD subject

- Key challenges:
 - ➡ Large-scale models (in space and time), based on the models developed in the project
- The objective of this thesis is to **exploit the two models** developed in the project at **a larger scale to simulate the flows** on crowded streets at a real mass gathering, the Festival of Lights in Lyon, and to validate it with the temporal gathered data.
- Emulating this real scenario will call for **adequate data assimilation methods** and efficient multi-agent simulations based on the two models.