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FRONTIERS OF LIFE | CRI - UNIVERSITY OF PARIS

FdV Bachelor | Modelling Project Week

Modelling socially awkward crowd in a subway wagon

*We want to model the **dynamics of agents** evolving in a subway wagon to study the impact of the **geometry of subway** (position of seats and metal pole) on the **flow and the final distribution of agents** as well as the number of users that were able to find a comfortable place.*

Model

The location of users in a subway wagon are subject to **complex dynamics** : people want a **comfortable place** while **avoiding proximity to other people**. Added to the constant flow of subway users entering and exiting the wagon, these dynamics results in **more or less efficient flow of people**.

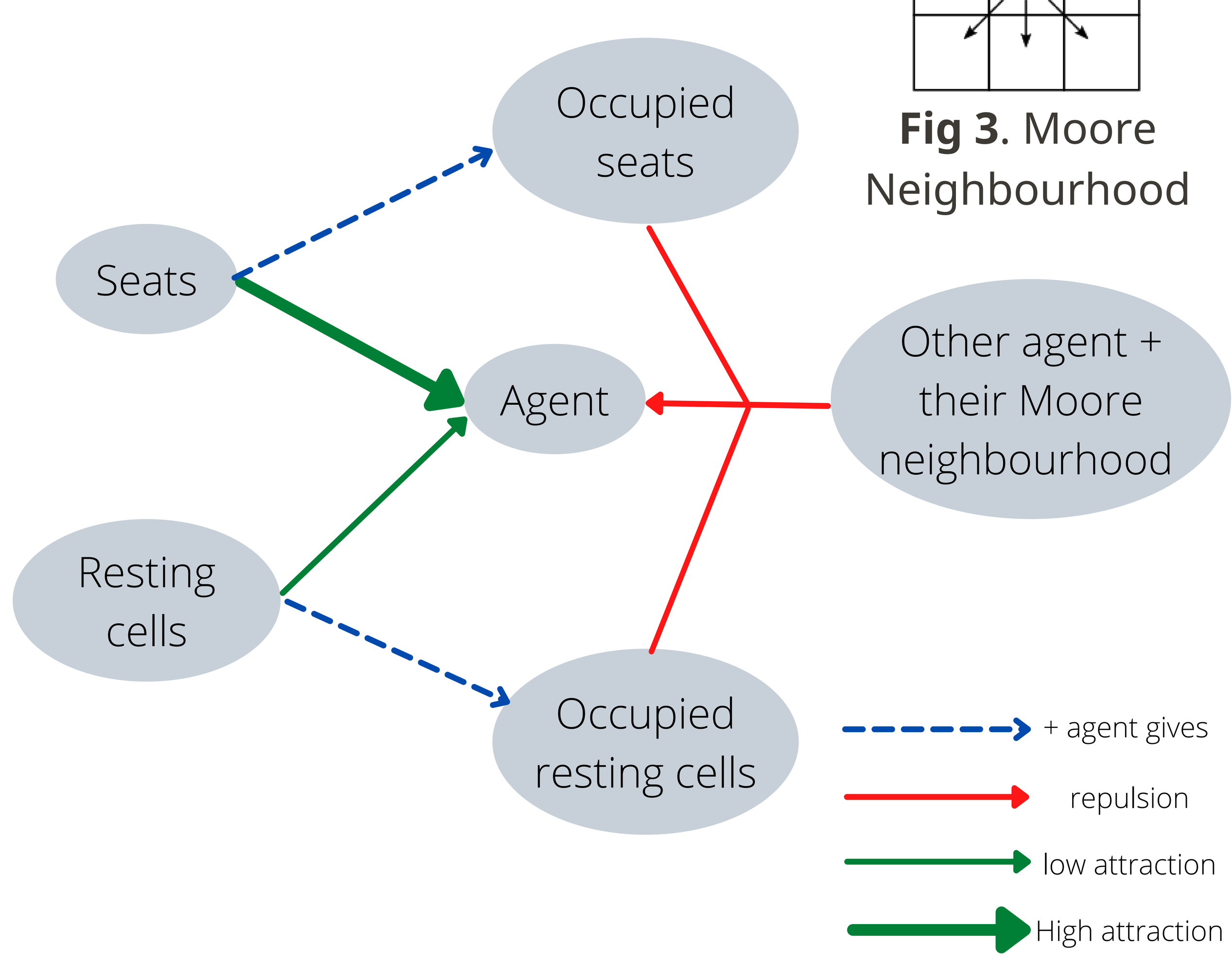

Fig 1. Interactions between the different components of our model

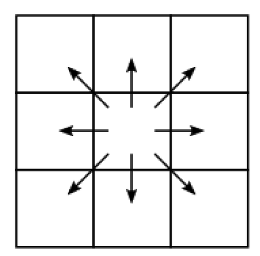

Fig 3. Moore Neighbourhood

We propose a cellular **automata model** describing the interaction between agents, walls of the metro, seats, and rest position.

One key part of this model is the **comfort matrix**, which assigns a value to each cell to allow each agent to choose its goal.

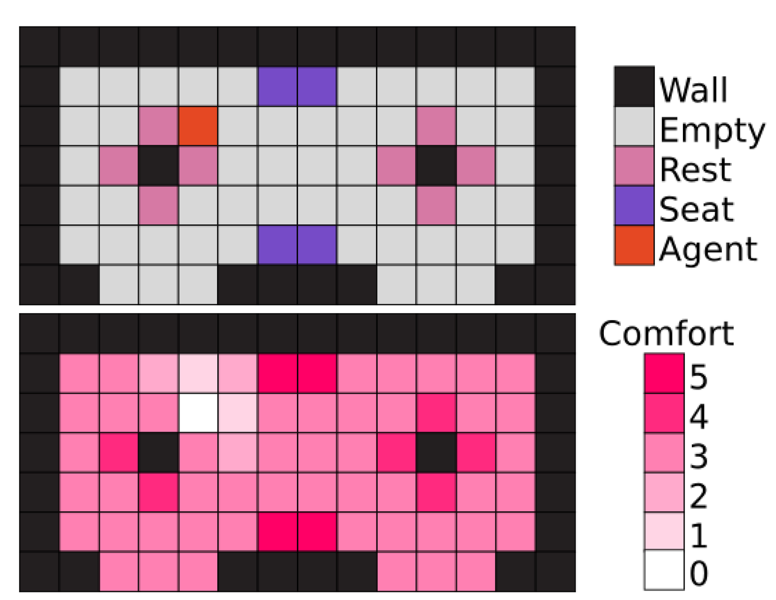

Fig 2. Exemple of a wagon and the comfort of each of its cells

At each iteration in our model, we **compute the comfort** of each cell. Then, each agent choose a **goal cell** (which seems comfortable) and its **next move** accordingly. Finally, we **solve conflict** caused by multiple agents trying to move to the same cell by **selecting randomly** the agent allowed to move to the cell.

Implementation

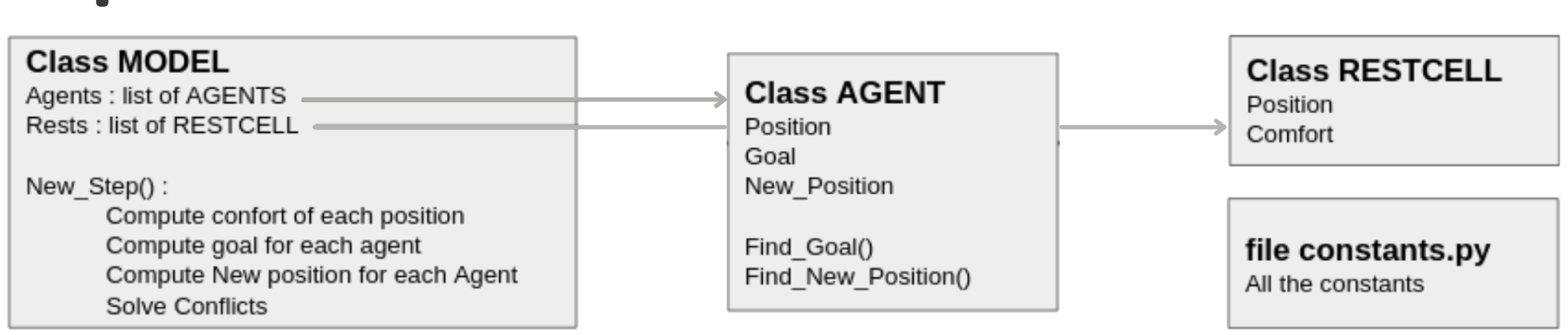

Fig 4 : Architecture of our package

Detecting conflicts : We detect conflicts (two agents trying to move to the same position) in computationaly efficient manner by putting the position of agents in a hash function.

Visualization : We generate vector images in the svg format for direct visualization in notebooks

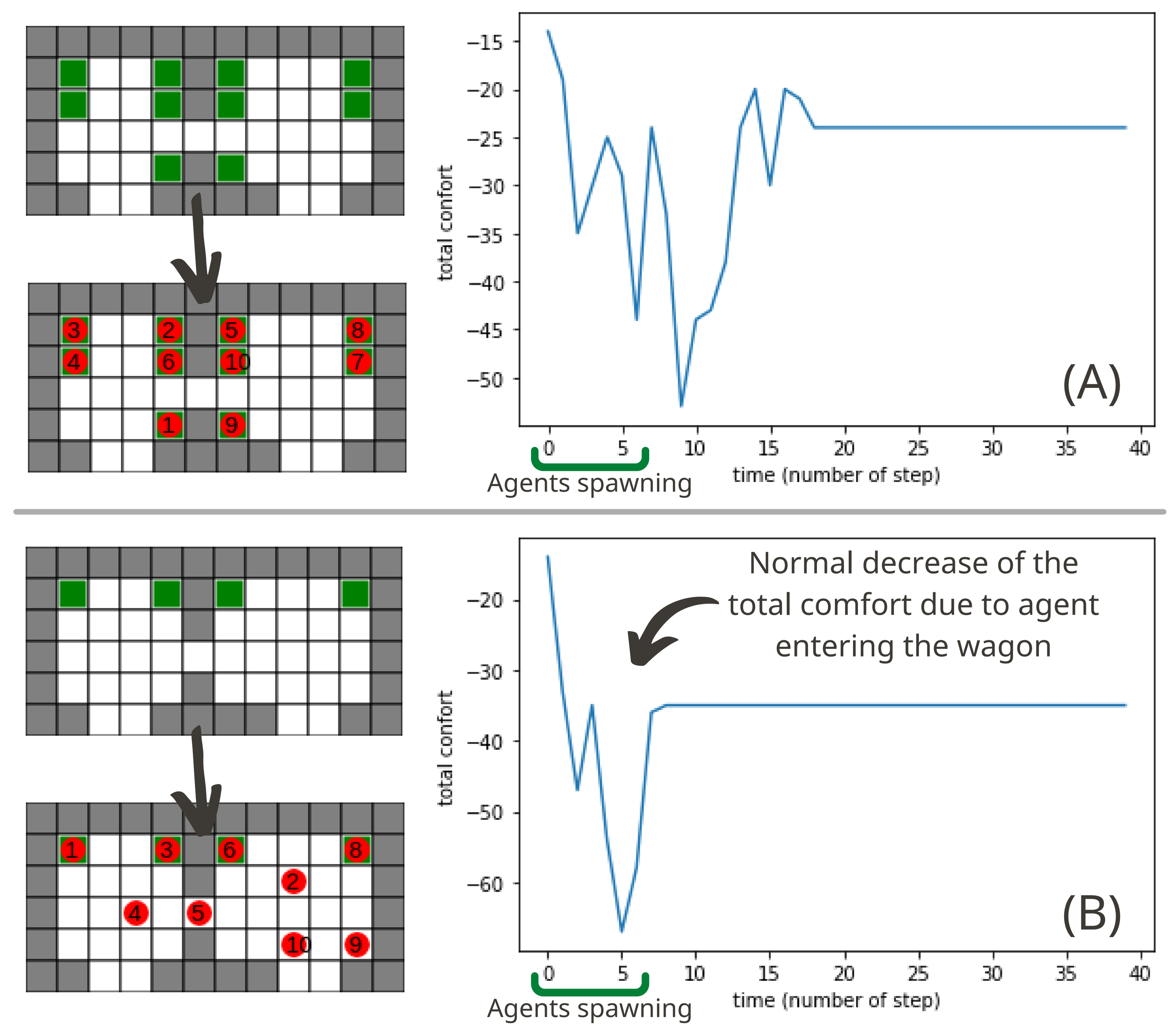

Fig 5. Total comfort of the 10 agents over time for a metro wagon with (A) 10 seats and (B) 4 seats.
Agent enter the wagon gradually during the 6 first iterations

Results

Simulation (B)

We were able to simulate our model **reliably** for a wide virety of initial conditions, and to record the **total comfort** of the agents as the sum of each agent's cell comfort over time.

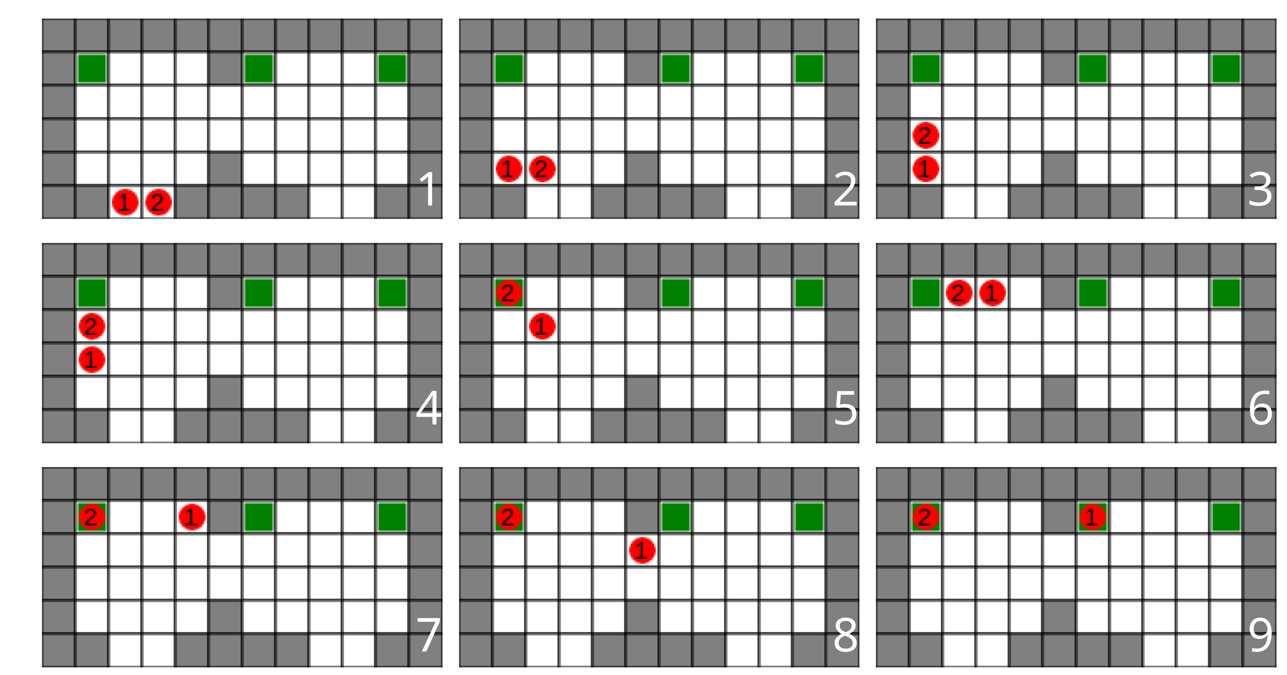

Fig 6. Example of dynamics with two agents for 3 seats.
The system reaches equilibrium after 9 iterations

Limits

When an agent is seated, he still is influenced by the negative comfort value of the Moore neighboorhod of other users. When another agent is too close, the agent will leave his seat because another free seat has become more attractive. This can sometimes lead to **infinite oscillations**. We could fix his position once he reaches a seat, but that goes against a dynamical system.

Simulation (A)

Alternative simulation (A)

Example of infinite oscillations (happens even though the initial conditions are the same because of randomness)

Agents can't spot if another agent has the same goal as them. Thus, they are wasting time on **unreachable goals**. They also are not aware of their close neighborhood. They only focus on their goal and the nearest cell to the goal. But they are not intelligent pathfinders. They would get stuck behind a wall whose position is close to the goal and would not know how to move around it.

Links

https://github.com/drblobfish/subway-crowd-cellular-automata
https://projects.cri-paris.org/projects/1ploTJ6e

Bibliography

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