Simulation on Natural Selection

Grupo 10

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Problem Description

We wanted to simulate an environment where **Animals** compete to get **Food** and reproduce, passing **traits** to their children.

Which traits dominate? How does the population evolve?

- Animals walk randomly through a gridded space which **consumes energy**
- Animals have individual **traits** like speed, size and perceptiveness
- If a given animal is big enough, it may **consume other animals**
- A faster and/or bigger animal spends **more energy** than a slow and/or small one

- 0 food → death
- 1 food → survival
- 2+ food → survival and reproduction

Dependent and Independent Variables

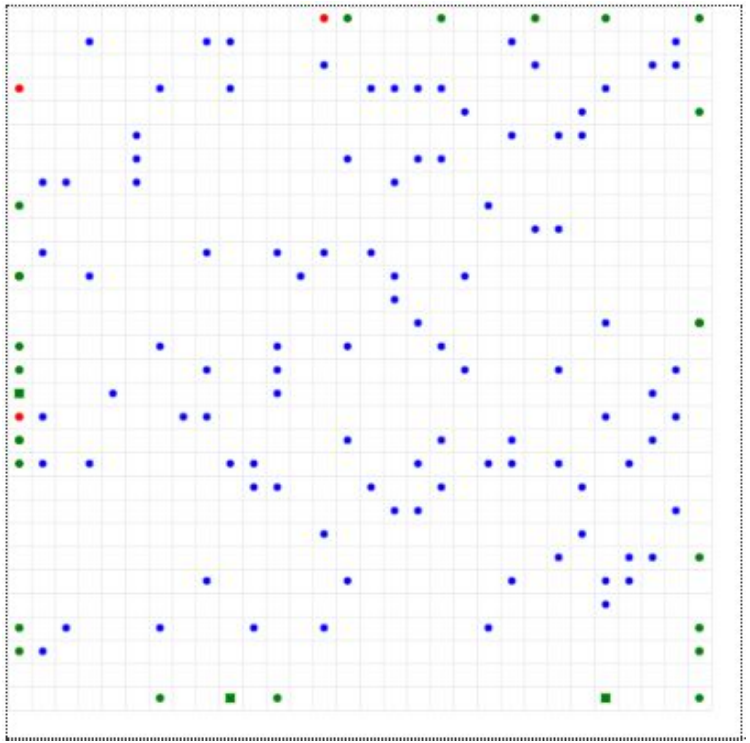
Independent

- Energy
- Starting population
- Food in the environment

Dependent

- Population evolution
- Amount of fast/slow animals
- Amount of perceptible animals
- Mean size of the population

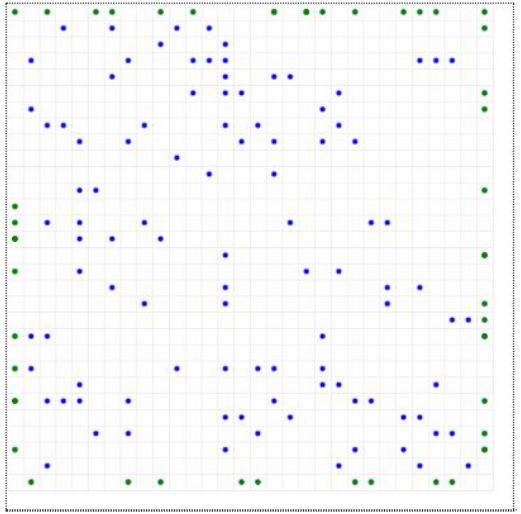
Visualization of the Simulation

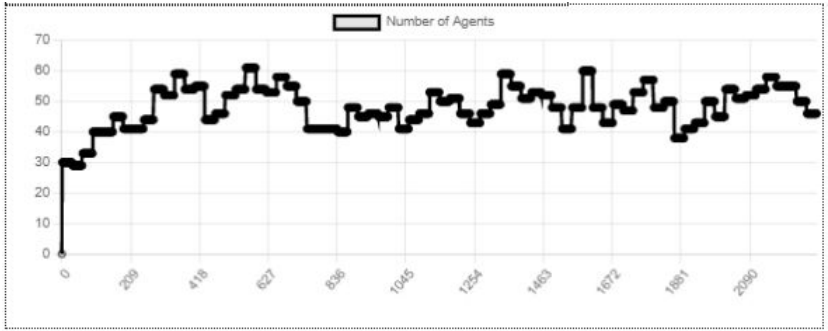


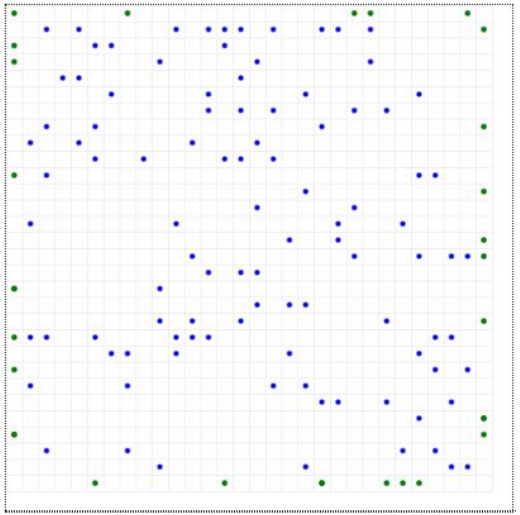
To visualize the population and its behaviour we used the **CanvasGrid** and **ModularServer** classes from Mesa

- Food → Blue circles
- Slow animals → Green circles or squares if perceptible
- Fast animals → Red circles or squares if perceptible
- Size of the animals → size of circle/square

Experience 1

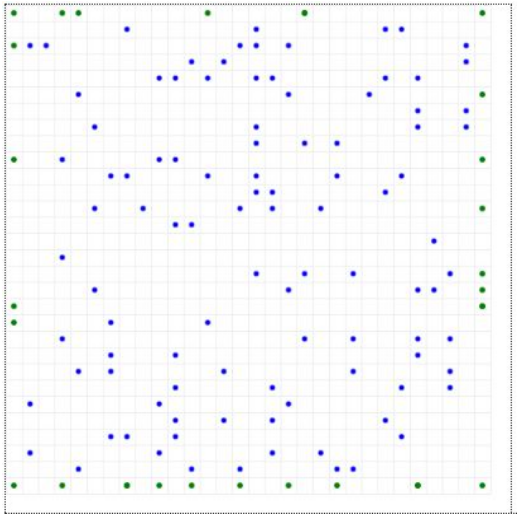


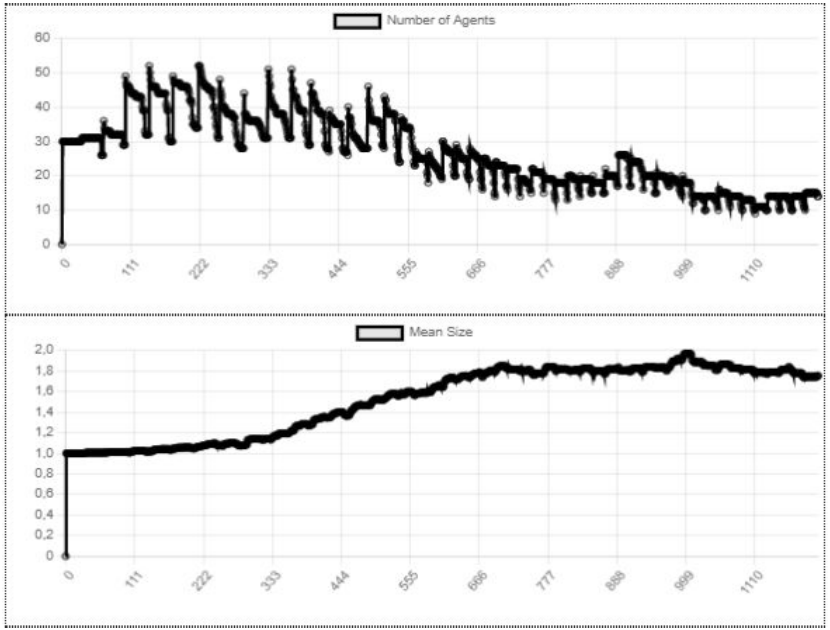


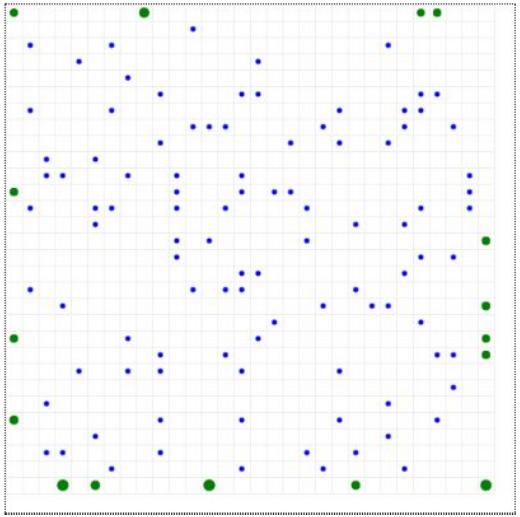


Experience with **30 agents** competing for food.

Experience 2

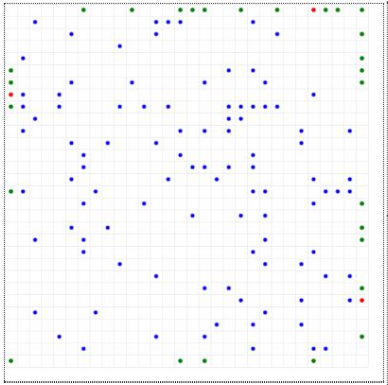


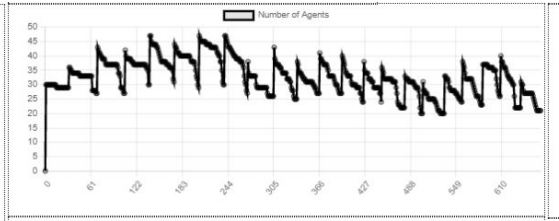


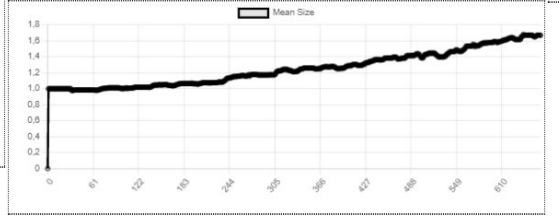


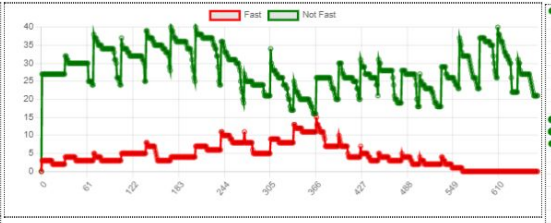
Experience with **30 agents** competing for food with mutations in **size** when they reproduce.

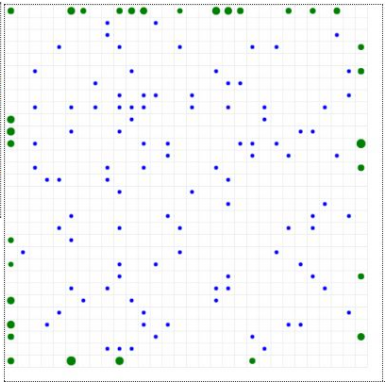
Experience 3





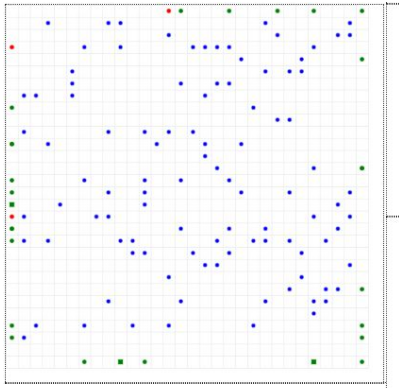


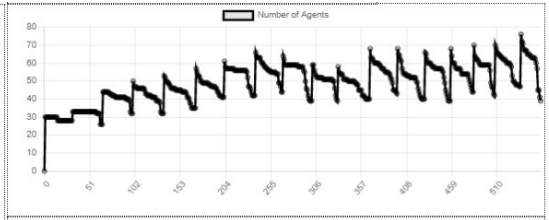


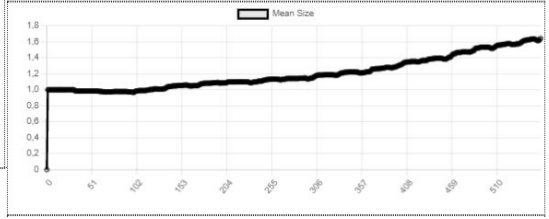


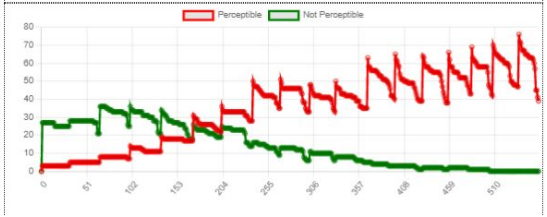
Experience with **30 agents** competing for food with mutations in **size** when they reproduce and with the addition of **3 fast** agents.

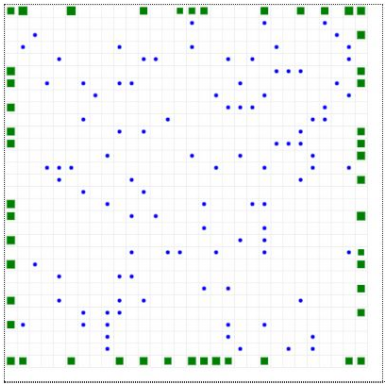
Experience 4











Experience with **30 agents** competing for food with mutations in **size** when they reproduce, the addition of **3 fast** agents and **3 perceptible** agents.

Future Work

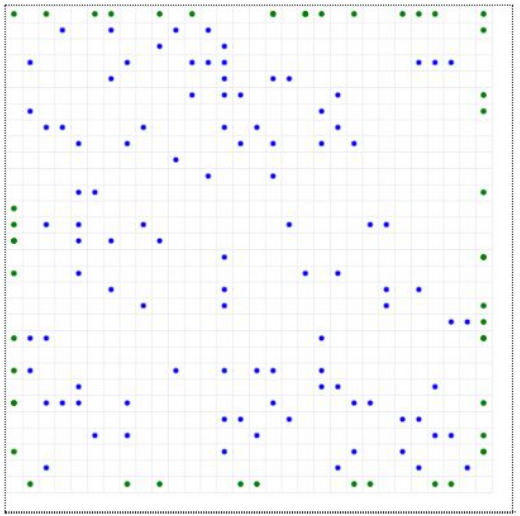
- Changing to a continuous space and add different traits (or modify speed to be continuous, for example)
- Batch-run implementation
- Adding more intelligence with better pathing and mechanics for chasing animals
- Adding reinforcement learning

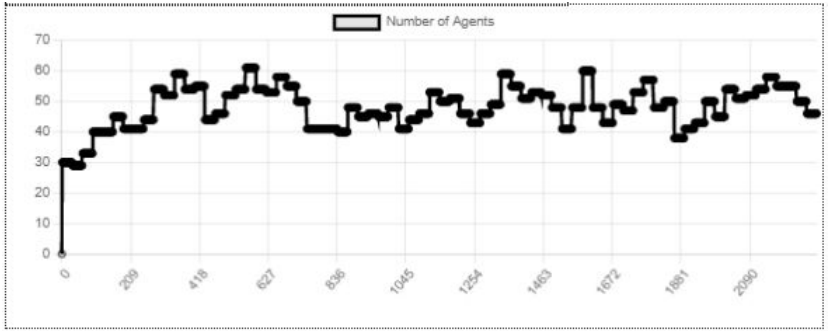
Documentation with detailed executions

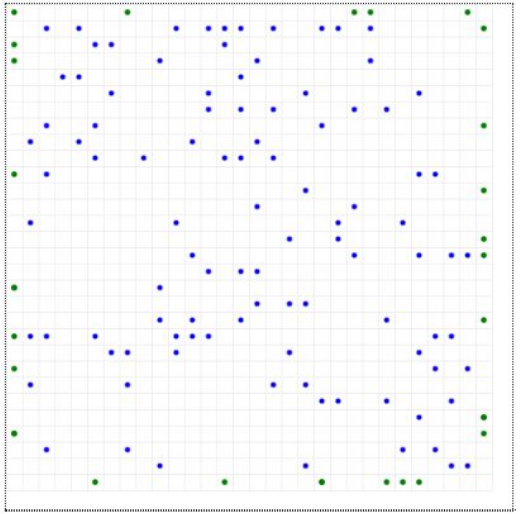
In this section, we further detail the executions of the experiences, explaining how runs proceeded and with the concrete amounts assigned to each variable.

All the project’s code was developed with the help of Mesa’s library for Python

Experience 1

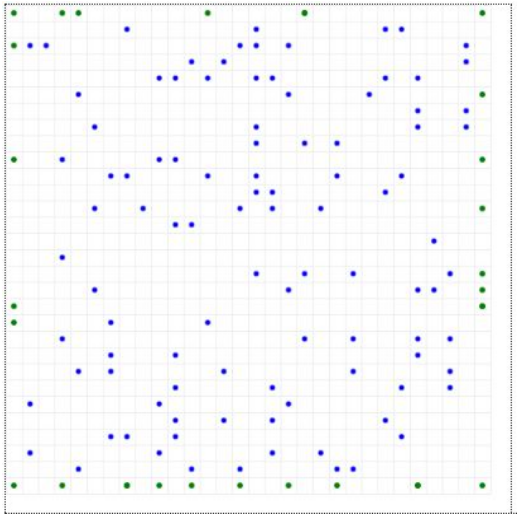


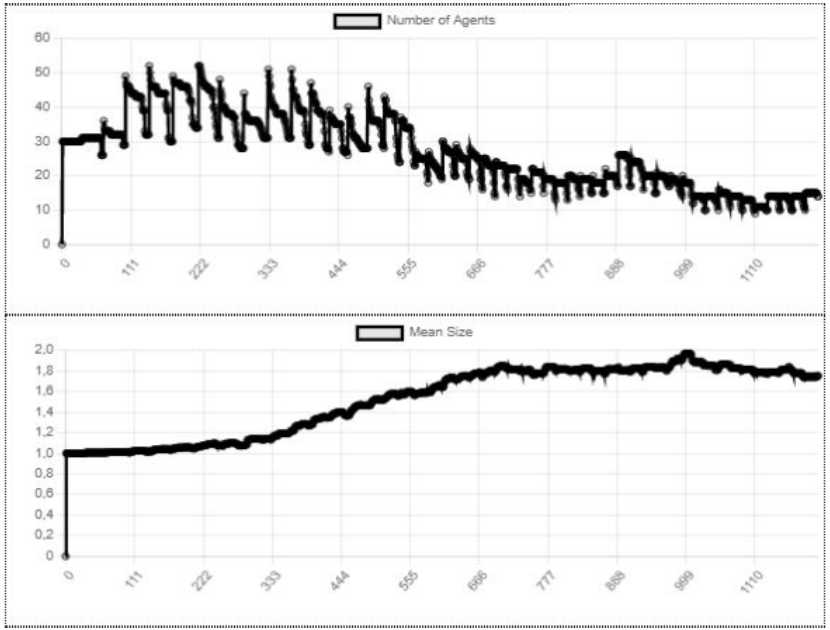


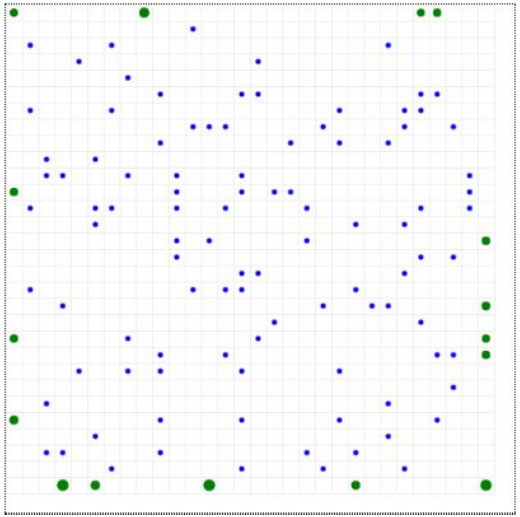


Experience with **30 agents** competing for food.
The number of agents tends to converge to a number between **40 and 55**. Multiple **highs** and **downs** can be observed due to the **overpopulation** and **scarcity of food**. The **death** of many agents results in **underpopulation** which leads to **multiple reproductions**, which itself results in **overpopulation**, creating a **cycle.**

Experience 2

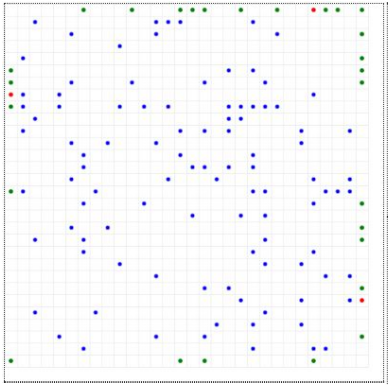


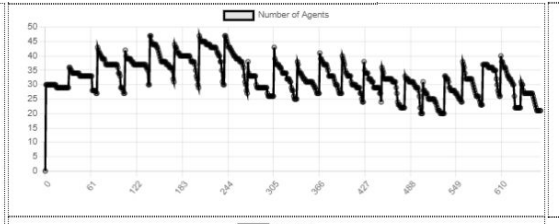


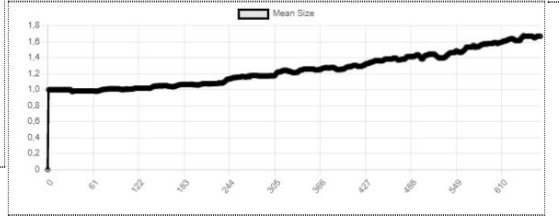


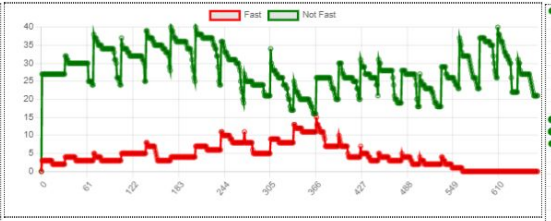
Experience with **30 agents** competing for food with mutations in **size** when they reproduce. The size stabilizes at a value of around **1.8**, which is the **optimal** value for the size of the agents. The increase in size results in the **decrease** of the number of agents.

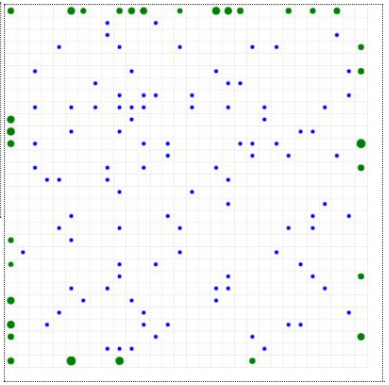
Experience 3





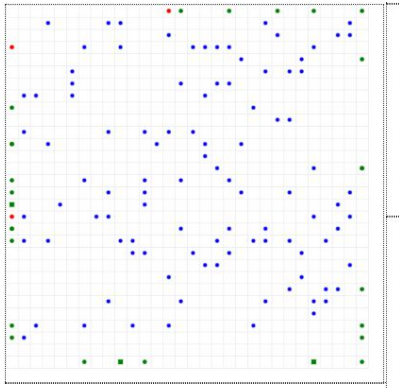


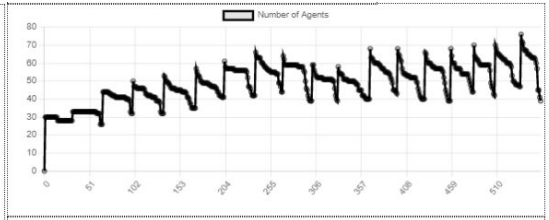


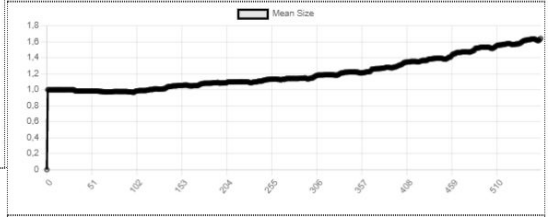


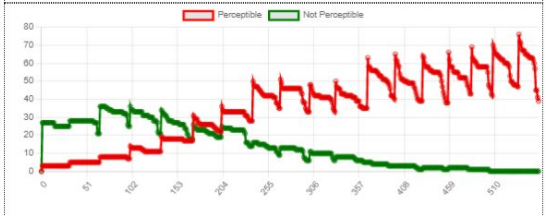
Experience with **30 agents** competing for food with mutations in **size** when they reproduce and with the addition of **3 fast** agents. Being **quick** isn't a good enough trait to **dominate** the current population. The number of fast agents quickly **diminishes**.

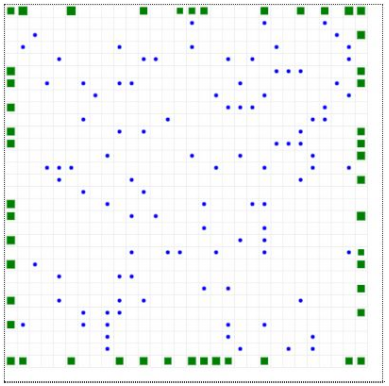
Experience 4











Experience with **30 agents** competing for food with mutations in **size** when they reproduce, the addition of **3 fast** agents and **3 perceptible** agents. The **“perceptible”** trait is good enough to **dominate** the current population. The number of **perceptible** agents steadily increases until all of them are perceptible. The number of total agents is also **superior** to the previous experiences due to **better survivability**.