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Leonardo Grando

Por su participación en Using a classical model to provide insights through Agent-based Simulation en el 12° Congreso Internacional de Investigación UVM, realizado con sede digital en Campus Tuxtla.

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Using a classical model to provide insights through Agent-Based Simulation

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Objective:

Create an Agent-Based Simulation Model model to simulate a **drone swarm energy supply** using as reference a classical economic model **El Farol Bar Problem** [Arthur 1994].

Fig 1 - Drones Swarm Representation in Model

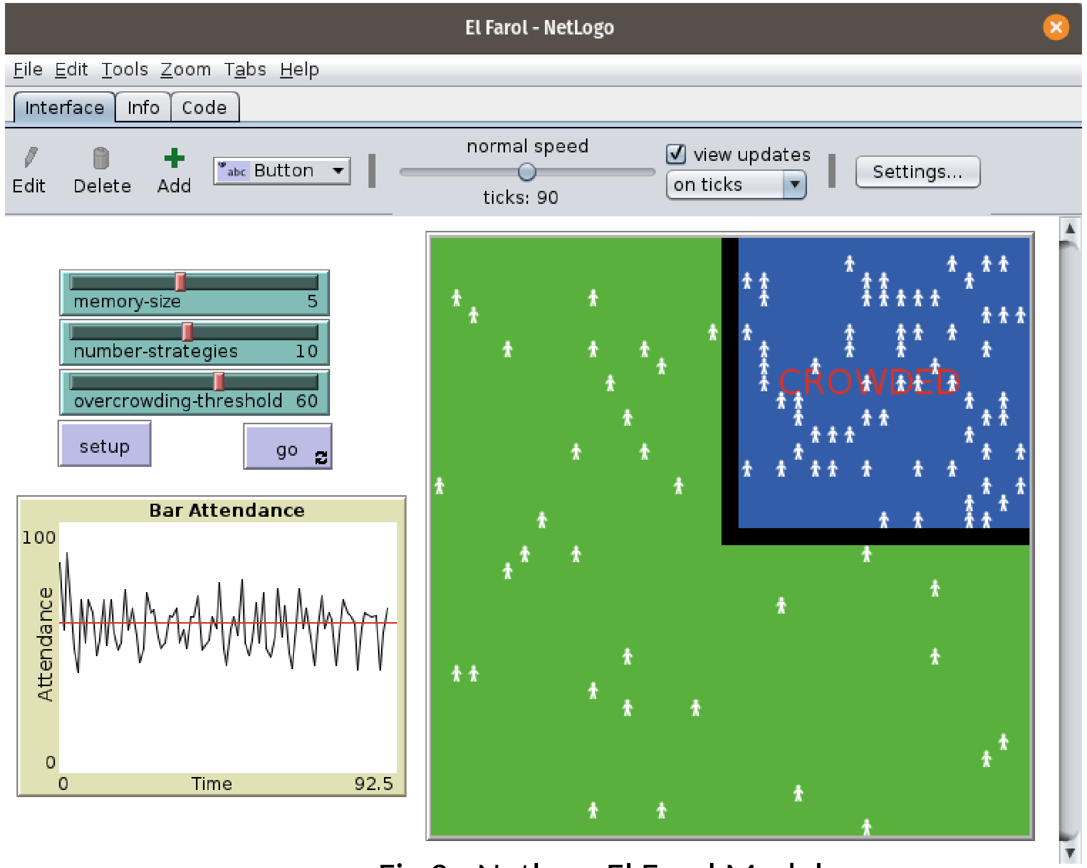

Fig 2 - Netlogo El Farol Model

Classical Model: El Farol Bar Problem (EFBP):
N agents
Confort threshold **B**
Agents have **m** last **L** attendance history to take their decision

- Each agent have a bag of k strategy (ex: moving average, cycle detector. and others)
- The unique information was the last attendance values.
- Theses strategies compete with each other inside agents.

If L > B → All agents have an unpleasant night
L ≤ B → All agents have a good night

- **Model already used in another's congestion problems and analogies (Table 1)**

Example: Minority game - used to simulate stock market [Challet, Marsili and Zhang. 2000].

- **Agents Decisions were made by an inductive way (not rational);**
- **No communication between agents;**
- **Fluctuations around a threshold;**
- **Nash Equilibrium (60/40)**

Table 1 - EFBP Analogies

Authors	Analogy
[Challet e Zhang 1997]	Minority Game.
[Cara, Pla e Guinea 1999]	Majority Game.
[Bell e Sethares 1999]	Congestion and coordination problem.
[Challet, Marsili e Zhang 2000]	Minority game.
[Sharif, Huynh e Vidal 2011]	Truck marine congestion modeling.
[Chakraborti et al. 2015]	Kolkata restaurant problem.

Energy supply is a big problem for IoT devices, we can improve by:

- Reducing device energy usage;
- Better energy supply;
- Better energy ways.

Simulation objective: Create a drone swarm recharging coordination procedure → Drones swarm can continue their jobs perpetually.

Jobs as: Disaster recovery [Horio et al. 2019], Products delivery[Zoricak 2013], Security, Survey, Monitoring, Surveillance, Leisure Pursuit, Environmental Mapping, Search and Rescue[Tahir et al. 2019], bringing Cellular Connectivity after a Hurricane that destroys a telecommunications infrastructure in Porto Rico [Mazur e Wiśniewski 2018], Aerial Cinematographers[Caraballo et al. 2020]. Wild forest spot fire detector [Hampson 2021]

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Our analogy

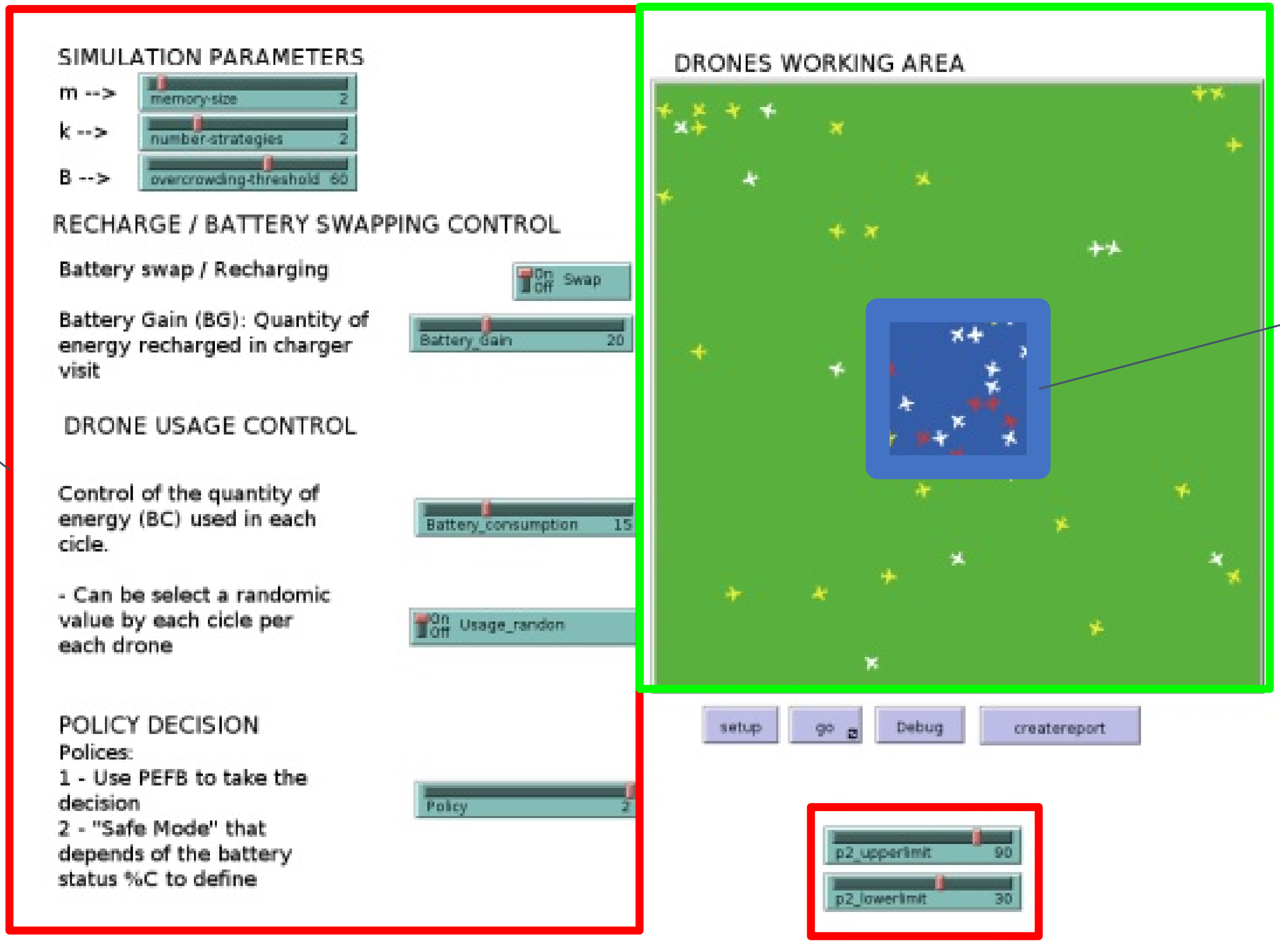

Fig 3 - Simulation GUI - Netlogo

The model development needs to consider some characteristics as:

- Physical: Battery Capacity, Energy supply (recharging or swap), battery usage, and recharging rates;
- Logic: When battery recharging, drones states (working or charging, or inoperative).

Boggio - Dandry and Soyata (2018) propose seven steps to a perpetual drone's flight:

1. **Ready** Drones are in the charger ready to fly;
2. **Flying in swarms** Drones are flying in swarms and making their job;
3. **In swarms awaiting recharging** Drones need to recharge and are on stand-by to be replaced by another drone;
4. **Flying to the swarms** After recharge drones return to fly;
5. **Flying to the charger** Drones return from the fly to the charger;
6. **In the charger queue** Waiting for the charging place to be released to charge;
7. **Charging** Drone in charging process.

Our model has its recharging logic inspiration in this model

Model Abstractions:

- The recharging only occur if L ≤ B and near B;
- We consider no time expended to recharge or battery swap;
- No communication between drones about their recharging decision (another's communication types can happen)
- The recharging process didn’t consider a queue.
- Drones don’t have a path or a job description (but a random battery usage);

Table 2 - Model Abstractions

Item	Model	Analogy
Agents	Bar goers	Drones
Bar (blue area)	El Farol Bar	Recharging Place
Neighborhood (green area)	El Farol Bar neighborhood	Drone’s working area
Threshold	EFB comfort limit	recharging threshold limit
Attendance	Quantity of bar goers	Drones that’s attend the recharging place

Conclusions:

- When developing a simulation model, we always need to check if the model has adequate accuracy with the study subject (Validation) and if we are creating the correct model (Verification) ;
- It's an endless game;
- This work is under development, publications and results were in progress.

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