Grouped Unification & Rendezvous Task

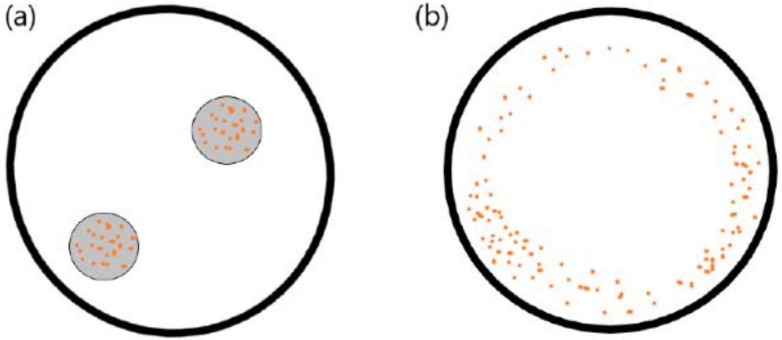
Group Dolores
Timofei Polivanov & Sami Rahali

Introduction - Problem description

- Agents in swarm robotics operate with only local sensing, without global knowledge or centralized control.
- A key behavior is aggregation: agents self-organize by gathering in the same location.
- This simulation uses predefined shelters as aggregation sites.
- The challenge: encourage agents to converge to a single shelter, not split between multiple.
- Behavior is modeled using Probabilistic Finite State Machines (PFSMs), inspired by natural swarms like cockroaches.

Introduction - Purpose of the simulation

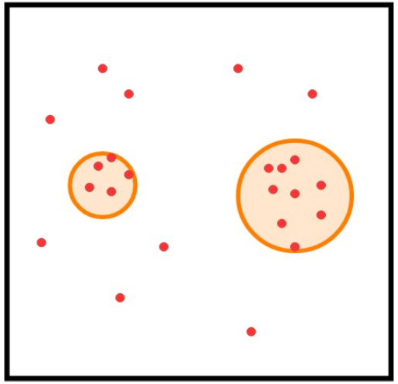
- Explore how agents self-organize into groups using only local rules.
- Analyzing agents aggregation behavior in environments with multiple or no shelters.
- Investigate whether agents show a preference for larger shelters.
- Understand what impact specific parameters have on the collective behavior.



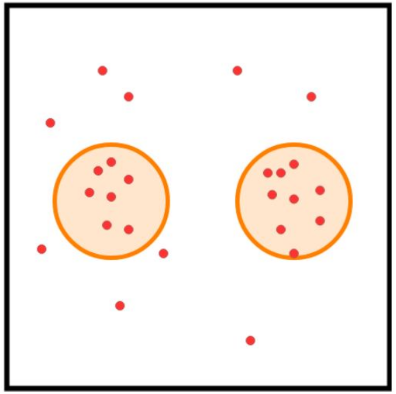
Introduction - Type of analysis being done

- Two experimental conditions:
  - Experiment 1: Two shelters of different sizes.
  - Experiment 2: Two shelters of equal size.
  - Experiment 3: No shelters.
- Observe agent distributions over time:
  - Which shelter is selected?
  - How long does convergence take?
- Collect data using:
  - Snapshots of simulation states.
- Plot results using various metrics.

Different Size Aggregation Zones

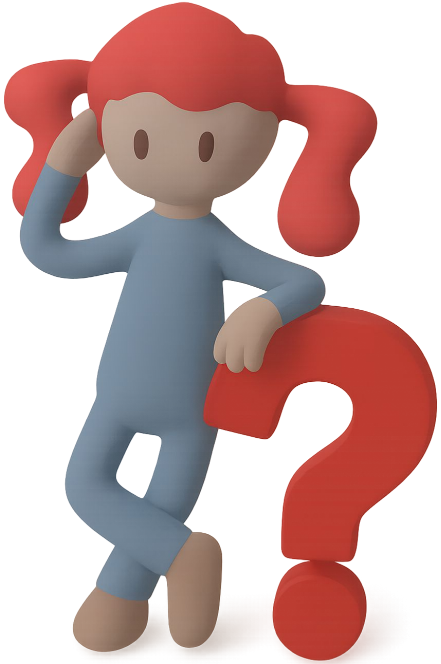


Same Size Aggregation Zones



- Problem scope explanation - explain voltera thingy model and predator pray shi
- Explain specifics of our sim implementation with all components - how agents work, and what parameters control them
- Show two sims - energy free and energy
- Research question - how do all the params affect the sim and populations and shi
- Methodolody - 2 baseline tests and then parameter variation
    - Explain what parameters we be tweakin
    - Explain what metrics we be usin
- Results
    - A shit ton of graphs and shi and statistics ong
- Discussion
- Conclusions - sum results and basically explain how each param affects shi

Introduction - Research Questions

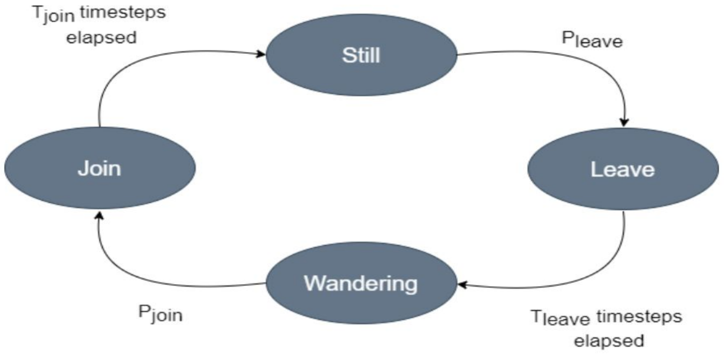


- To what extent does the size of aggregation areas affect the agents' collective gathering behavior?
- What is the optimal value for agent perception radius to achieve the most compact aggregation?

Methodology

Agents follow a Probabilistic Finite State Machine (PFSM) with four key states:

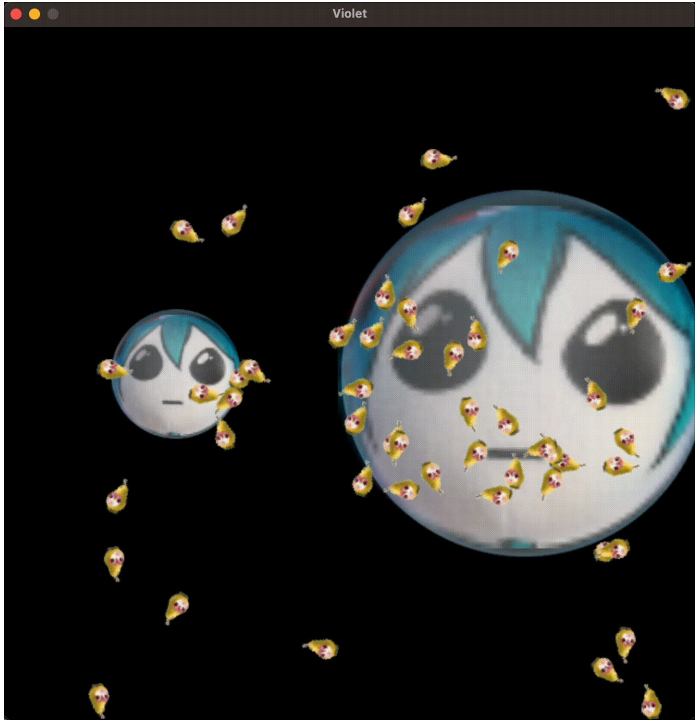
- Wandering: Agent searches randomly for groups.
- Join: Moves towards a group, then freezes.
- Still: Forms part of an aggregate, agent becomes stationary.
- Leave: Departs from an aggregate, returns to wandering.

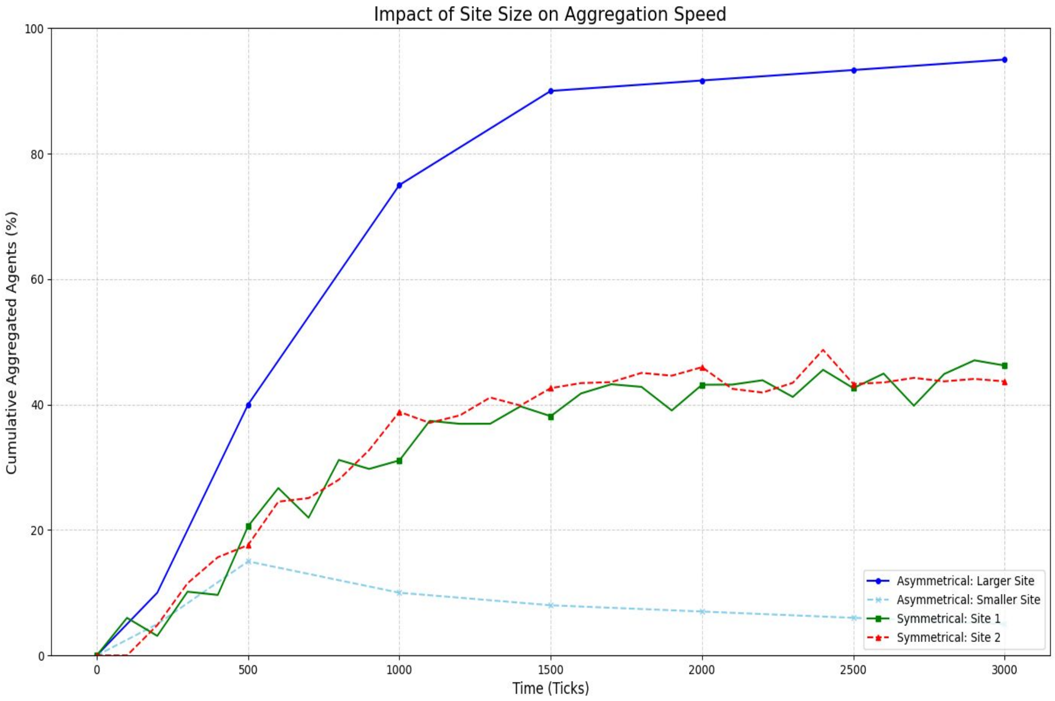


Transitions are controlled by decision mechanisms:

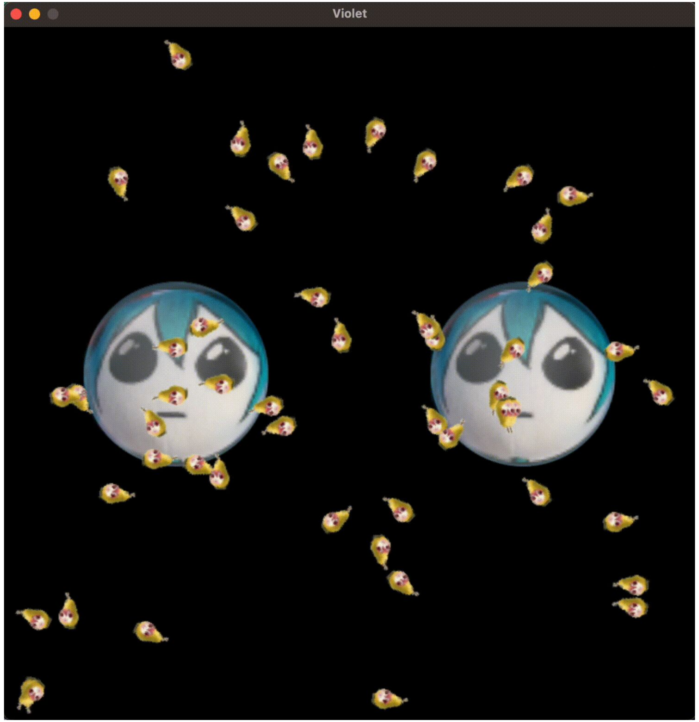
- P_join: Probability of joining a group. Increases with more neighbors.
- P_leave: Probability of leaving a group. Decreases with more neighbors.
- Timers (T_join & T_leave): Delay transitions to avoid agents clustering at edges or rejoining too quickly.
- Neighbor Count: Influences state transitions.

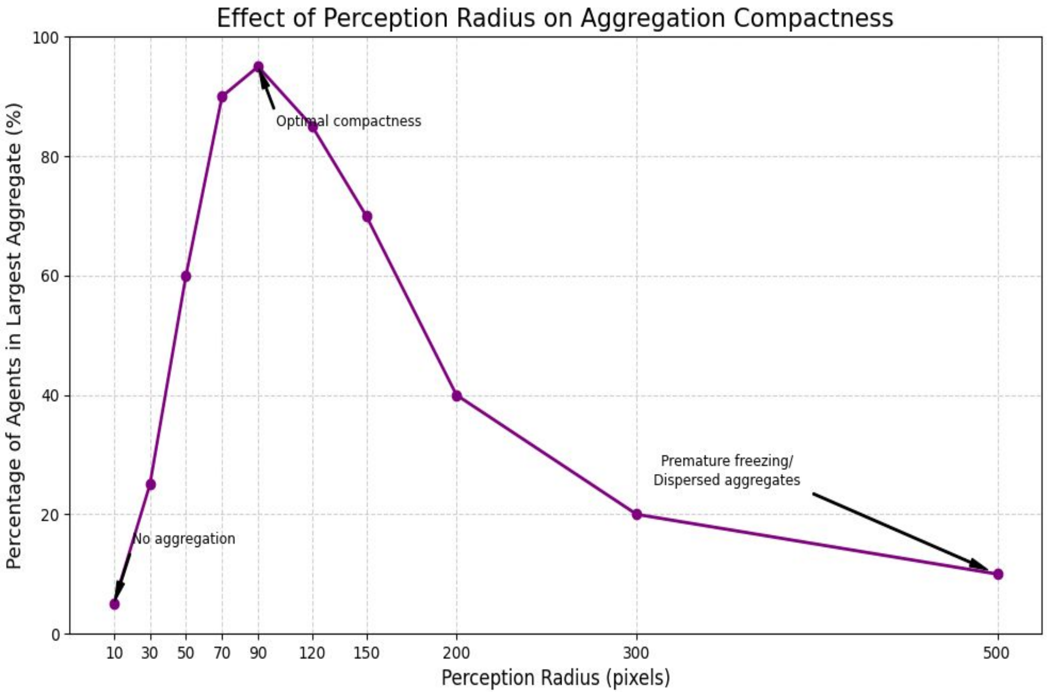
Results - experiment 1



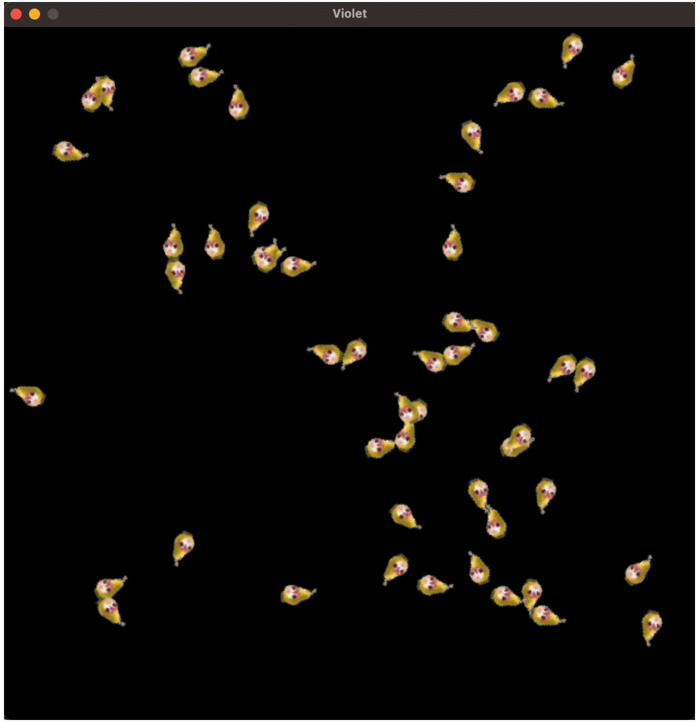


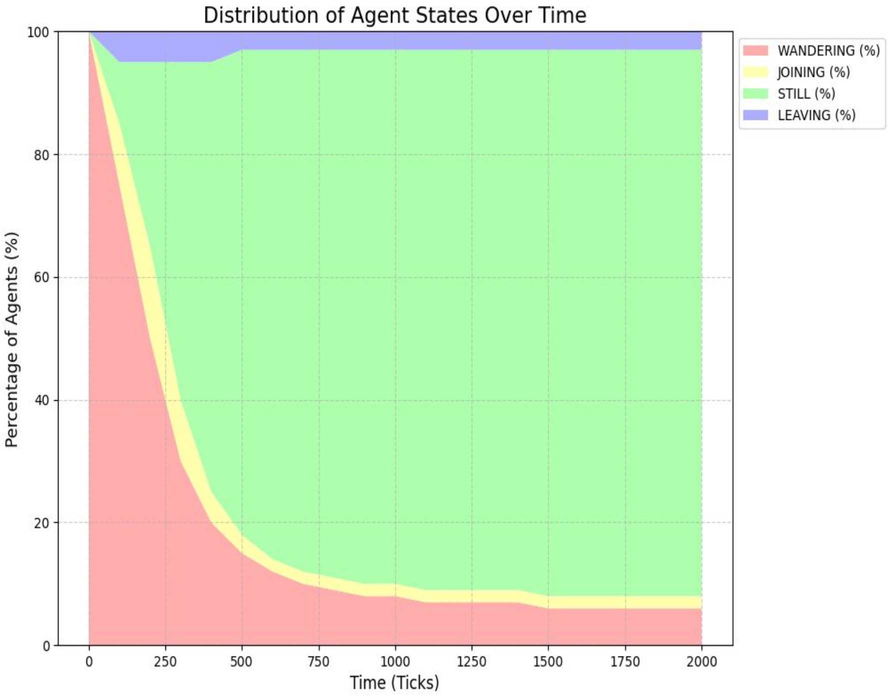
Results - experiment 2





Results - experiment 3





Conclusions

- RQ1: The bigger the site area - the higher the probability of agents aggregating inside of it. When the sites are equal - the probabilities are equal.
- RQ2: Values in the range 60-120 are the most optimal. Below that - no aggregation occurs, above that - the resulting group is sparse.
- Experiment 3: Without sites, agents aggregate as is, and don't form optimal groups.