Driftwood Simulation Project

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Introduction

The Driftwood Simulation Project models resource competition and cooperation in a dynamic coastal environment. It explores self-regulation, peer-pressure enforcement, and external mechanisms like patrols and cameras. The aim is to understand how these factors influence resource stability and system resilience, offering insights into real-world resource management challenges like fisheries, public goods, and shared resources.

Key Objectives:

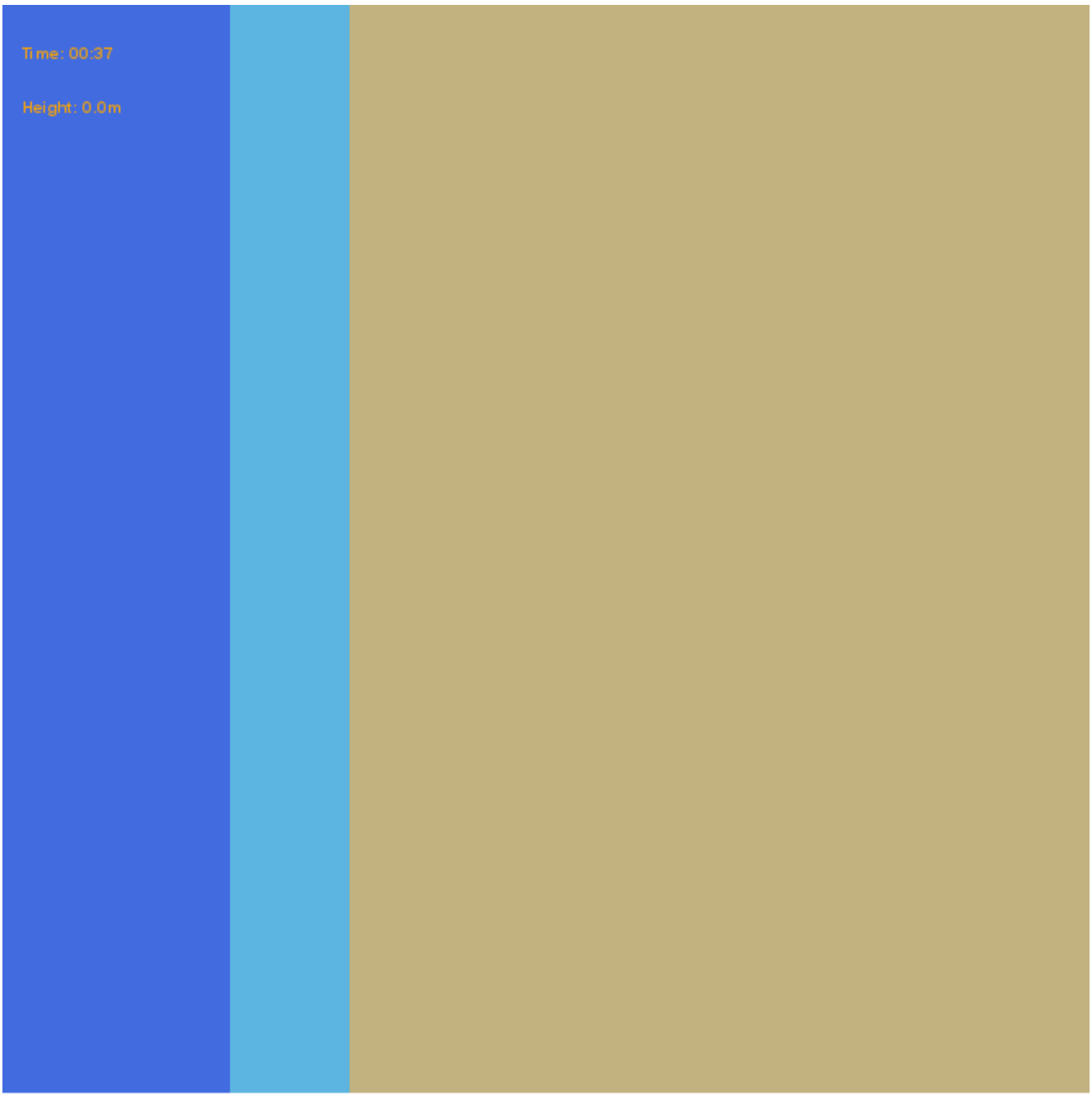
1. Evaluate the impact of theft and peer-pressure regulation.
2. Analyze the role of enforcement mechanisms.
3. Explore group dynamics and their effects on stability.

The Environment

The simulation is set in a grid-based environment that mimics a dynamic beach. This beach is divided into three zones:

- Ocean: Constantly shifting due to tides and waves.
- horeline: A highly dynamic zone influenced by tides.
- Dry Land: Stable but indirectly impacted by environmental factors.

Environmental factors like tides and waves make this setting dynamic and unpredictable. Tides rise and fall, altering the boundaries of the zones, while waves create oscillatory movements that influence both driftwood and agents. Metrics such as average height, tide levels, and wave dynamics allow us to quantify the environmental impact on collector behavior.



Driftwood Species

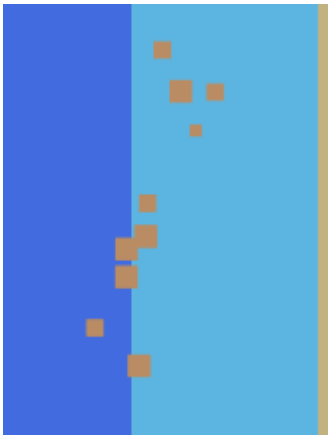
Driftwood is the primary resource in the simulation, influencing collector behavior.

Attributes:

- **Size Categories**: Small, medium, large.
- **Movement**: Smaller pieces are more affected by waves and tides, while larger pieces are more stable.
- **Value**: Ranges from 1 (small) to 5 (large).

Behavior:

- Driftwood moves based on environmental factors such as waves and tides.
- Movement patterns create challenges for collectors, who must adapt their strategies.

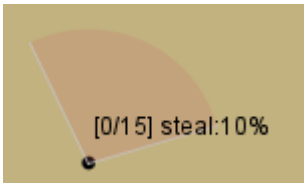


Collectors

Collectors are the primary agents in this simulation, tasked with gathering driftwood, creating piles, and occasionally stealing from others. Their behavior is influenced by several factors:

- Greed: Determines whether they continue collecting or return to deposit resources.
- Field of View: Governs how they detect driftwood and piles.
- Stealing: Adjusts probabilities based on their success.
- Grouping: Enhances efficiency but introduces complexity.

By dynamically responding to their environment, collectors navigate the challenges of resource competition, balancing their tendencies to hoard, collaborate, or steal. Metrics for analyzing their behavior include theft counts and collection efficiency.



WoodPile Species

WoodPiles represent collected driftwood stored by agents.

Attributes:

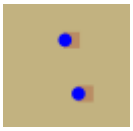
- **Ownership**: Tied to a specific collector.
- **Value**: The sum of the driftwood's values in the pile.
- **Stability**: Decreases with theft frequency.
- **Markers**: Visually identify ownership.

Behavior:

- Tracks theft activity and adjusts stability.
- Represents the core of resource competition and ownership dynamics.

Key Metrics:

- Pile value, times stolen from, and stability scores.



Enforcement Mechanisms

Two enforcement mechanisms operate in the simulation to maintain order:

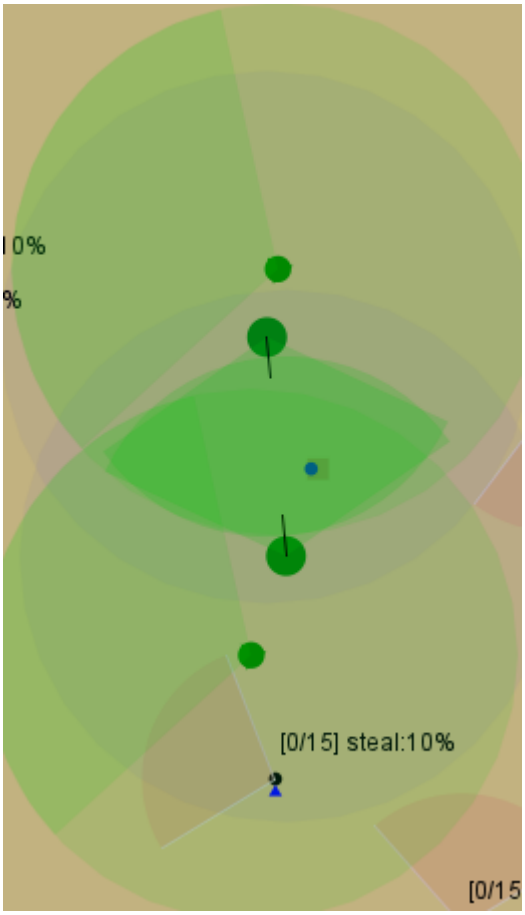
Mobile Authorities

- Patrol the environment, detecting and pursuing thieves.
- Impose penalties like reducing the thief's probability of stealing again.

Security Cameras

- Stationary cameras monitor specific areas with a rotational field of view.
- Detect theft and penalize thieves within their detection radius.

These mechanisms significantly reduce theft rates, with mobile authorities being especially effective in dynamic scenarios. Metrics like active pursuits and total catches help evaluate their success.



Group Dynamics

Group formation introduces social behaviors among collectors:

Attributes:

- **Group Size**: Min and max size constraints.
- **Formation and Breakup**: Probabilities govern group behavior.
- **Cooperation Bonus**: Increases efficiency within groups.

Behavior:

- Groups enhance resource collection but can lead to increased competition or theft.
- Group leaders assign tasks and maintain cohesion.

Key Metrics:

- Number of groups, grouped collectors, and average group size.

Experiment Design

The experiment is interactive, allowing parameter adjustments:

Parameters:

- Environmental: Wave height, tide rate.
- Collectors: Greed, stealing probabilities.
- Enforcement: Number and range of patrols and cameras.
- Groups: Formation and breakup chances, cooperation bonuses.

Outputs:

- Displays: Real-time visualization of the environment and agents.
- Graphs: Group vs. solo efficiency, theft rates, and stability.
- Monitors: Metrics for collectors, piles, and enforcement.

Key Insights and Results

1. **Peer Pressure**:
    - Moderately effective at reducing theft but lacks consistency.
2. **Enforcement**:
    - Patrols and cameras significantly reduce theft rates.
    - Mobile authorities are more effective in dynamic scenarios.
3. **Group Dynamics**:
    - Groups increase efficiency but can lead to resource conflicts without enforcement.

some results :

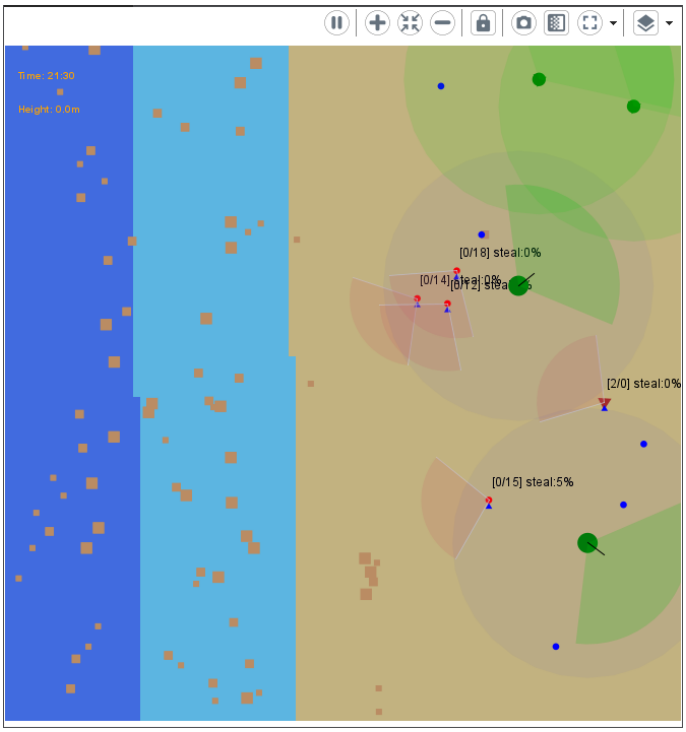
1. Group vs Solo Performance (Top-Right Quadrant) This graph highlights the comparison between grouped and solo collectors over time:

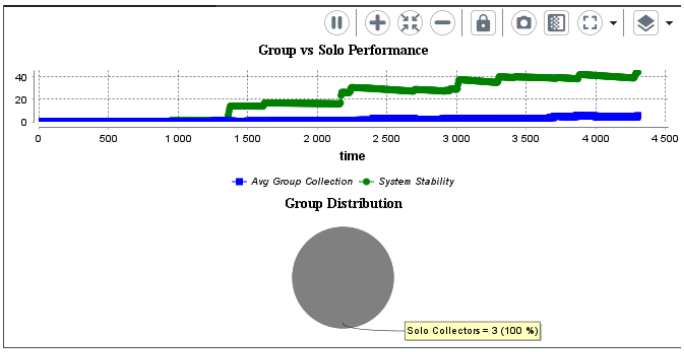
- Green Line: Represents system stability, which increases steadily, indicating effective enforcement and cooperative dynamics. Blue Line: Tracks the average collection efficiency of groups compared to solo collectors. While lower initially, it rises as groups form and improve coordination. Below the chart:

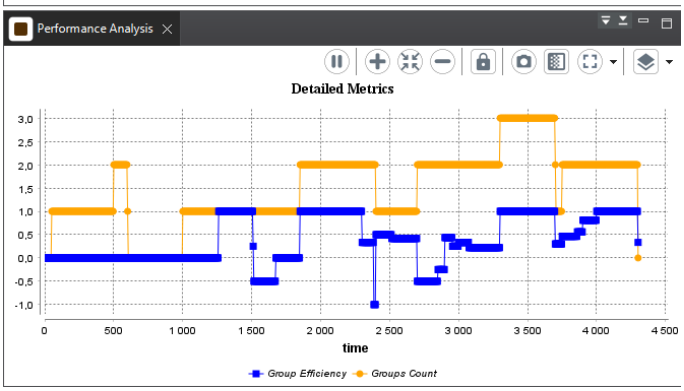
2. A pie chart depicts the distribution of grouped vs solo collectors. Here, 100% of collectors are solo, indicating no active groups at this point in the simulation.

3. Performance Analysis (Bottom-Right Quadrant) This section visualizes detailed metrics to monitor system dynamics:

- Blue Line: Tracks group efficiency over time. The fluctuating values indicate that group efficiency varies significantly across cycles.
- Orange Line: Represents the number of groups in the simulation, fluctuating as groups form and disband.
- Insights: Peaks in group efficiency align with increases in group count, suggesting that group cooperation contributes positively to resource collection.







Conclusions:

- System Stability: The green line in the performance chart reflects a steadily increasing stability metric, driven by effective enforcement mechanisms and low theft rates.
- Enforcement Effectiveness: The overlapping patrol areas and low theft probabilities suggest that security measures are successfully deterring theft.
- Group Dynamics: The absence of active groups suggests collectors are operating individually, possibly due to limited opportunities for collaboration.

Conclusion

Summary:

- The simulation demonstrates how agents interact dynamically in resource management.
- Enforcement mechanisms and group behaviors play pivotal roles in stability.

Final Thoughts:

- This project provides insights into balancing competition, cooperation, and enforcement in shared resource systems.