Trading Lizards

1. Introduction

Trading Lizards is a simulation in which simple aspects of economy and biology are combined. It is a Cellular Automata that can house individual agents in each of its cells, and which uses an algorithm to manage the behavior of each agent, which represents a member of one of the species.

This document will present the physics of the simulated world, followed by the characteristics of the agents, and the actions they can take in the world, and finally will conclude on observed outcomes.

2. Mother Nature

The CA is simulating a world containing 4 regions, which are the homes of each of the species, and have a particular resource growing in them. The members of the species must travel to the other regions to acquire the set of 3 distinct resources necessary for reproduction. At the end of their journey, they must return to their homeland in order to mate with another agent of their species.

Traveling between regions is fraught with danger as it is the homeland of a 5th species, which will attack the unwary travelers. These predators also require 3 distinct resources to reproduce, and acquire them by recovering them from their prey. However they are asexual, and do not need a mate.

In order to determine the actual outcome of an agent's decision, and in order to keep all the agents synchronized, two passes are made through the CA. In the first one, each agent is required to make a decision. Trading and combat requests are resolved right away; movement and mating requests are stored, and conflicts are resolved during a second pass where the position of each of the agents (including the newly born) is set. If two agents attempt to move in the same spot, only one succeeds (50% chance for each). Since there are only two passes, this is of the same order of time it takes for a Game of Life to create moving entities (gliders), which only requires one pass; granted the rules require a lot more sophistication, the amount of time needed to compute the following time step is asymptotically the same.

By default, the program has trading turned off, and logging turned on. It is possible to run the simulation step by step, or have it run automatically by clicking on Run. Turning on cell borders may make tired agents more visible, but will slow down the program; turning logging off will on the contrary greatly speed it up.

3. Agent characteristics

Each agent begins with 200 energy units; their current energy level is represented by the brightness of their color. Moving consumes 1 unit, resting restores 10, consuming a resource restores 80, and when a predator fails to kill its prey it loses 50 units. Each agent can carry at most 12 units of each resource (so up to 48 units altogether).

Non-predators pick at random one of the resources they are missing, and start heading for the region growing that resource. Predators just roam around at random and attack their prey when they are within reach; they are not allowed to enter any of the 4 regions.
4. Actions in the world

The successive time steps of the simulation determine the new position of each of the agents; this is obtained via a decision from each, made according to the information it has. At the beginning of the time step, each agent is given information on neighboring agents and on the direction of the position of each of the resources relative to its own. If an agent is in the same cell as a resource, it picks it up (even if it has the maximum amount of that resource, in which case the resource just disappears).

Possible actions:

- do nothing; this restores some energy. Agents have a small chance of picking this option; non-predators will also do so if their energy level falls below a certain point.
- move in a particular direction; each agent has 1 chance out of 5 of moving in a random direction.
- attempt to mate with the agent of a neighboring cell (and of the same species); this requires the agent to have returned to its starting region, and the consumption of a specific set of resources, which is not available in its totality in any given area of the world. The predators are asexual, and able to reproduce without a mate.
- consume a resource; an agent can only consume the resources from its starting region. It will choose to do so if its energy level falls too low, and will prevent it from having to rest and be a sitting duck for the predators.
- offer to trade a neighboring agent for one or more of its resources; if that agent has the currently sought after resource, it will offer to trade it for 1 to 4 units of the resource it has the most of (depending on how much of it it has). No agent will attempt to trade with a predator.
- attack a neighboring agent; predators have 40% chance of killing its prey, and of recovering all of its resources if it is successful. Otherwise it loses 50 units of energy.

If the energy level of one of the agents falls below 0, the agent dies on the following time step.

5. Conclusion: observed outcomes

Several situations are observed:

- the system remains stable, the predators keep each population level constant without themselves proliferating too much. This situation doesn't usually last forever;
- if trading is allowed, reproduction cycles are made shorter;
- some regions that are clear of predators can become overpopulated with agents, and congestion can occur, where agents can't leave a region to pursue their journey because of a ring of agents trying to come in to complete their cycle. This provides fertile spawning grounds for predators who happen to stumble by, as most of the agents there have all the resources necessary for reproduction;
- the predators might experience an explosion in population, and kill off one or more of the species, then become extinct themselves due to the consequent lack of resources available to them;
- if the predators die out, surviving species have their population explode in their turn.